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THE
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TO OUR GEOLOGICAL FRIENDS AND SUPPORTERS.

Our Sixth Volume is now completed, and we have again the pleasant task of thanking our numerous friends for having continued to support us; may the number of their names steadily increase, so shall our seventh volume be even better than its predecessor.

Especially are our thanks due to those of our friends who have not only supported the Magazine as Subscribers, but who have also contributed Original Articles, Notices, and Reviews to its pages.

The following new contributors have been added to our last year's list:—Dr. W. G. Atherstone, F.G.S.; Messrs. Samuel Allport, F.G.S.; H. W. Bristow, F.R.S., F.G.S.; Rev. T. G. Bonney, M.A., F.G.S.; Messrs. James Croll; J. R. Dakyns, M.A.; the Earl of Enniskillen, D.C.L., F.R.S.; Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S.; Prof. Harkness, F.R.S., F.G.S.; Messrs. Henry Hicks; G. A. Lebour, F.R.G.S.; R. Lightbody, F.G.S.; Prof. S. Loven, Stockholm; Dr. J. G. O. Linnarsson; Mr. J. A. Mahony; Prof. Owen, F.R.S.; Messrs. R. Russell; J. Rofe, F.G.S.; H. C. Sorby, F.R.S., F.G.S.; Rev. J. D. La Touche; Messrs. T. Thompson; Ralph Tate, A.L.S., F.G.S.; J. Clifton Ward, F.G.S.; W. Whitaker, B.A. (Lond.), F.G.S.; W. H. S. Westropp, M.R.I.A.

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As regards CORRESPONDENCE, we still are well supplied, but we must again threaten, that if our friends will send us such *long letters*, we shall be obliged to make an abstract for insertion, instead of printing them *in extenso*.

Our ARTISTS, and PRINTERS, and PUBLISHERS continue to do their best; and if only more Subscribers will lend us their aid, we are sure to succeed in the future.

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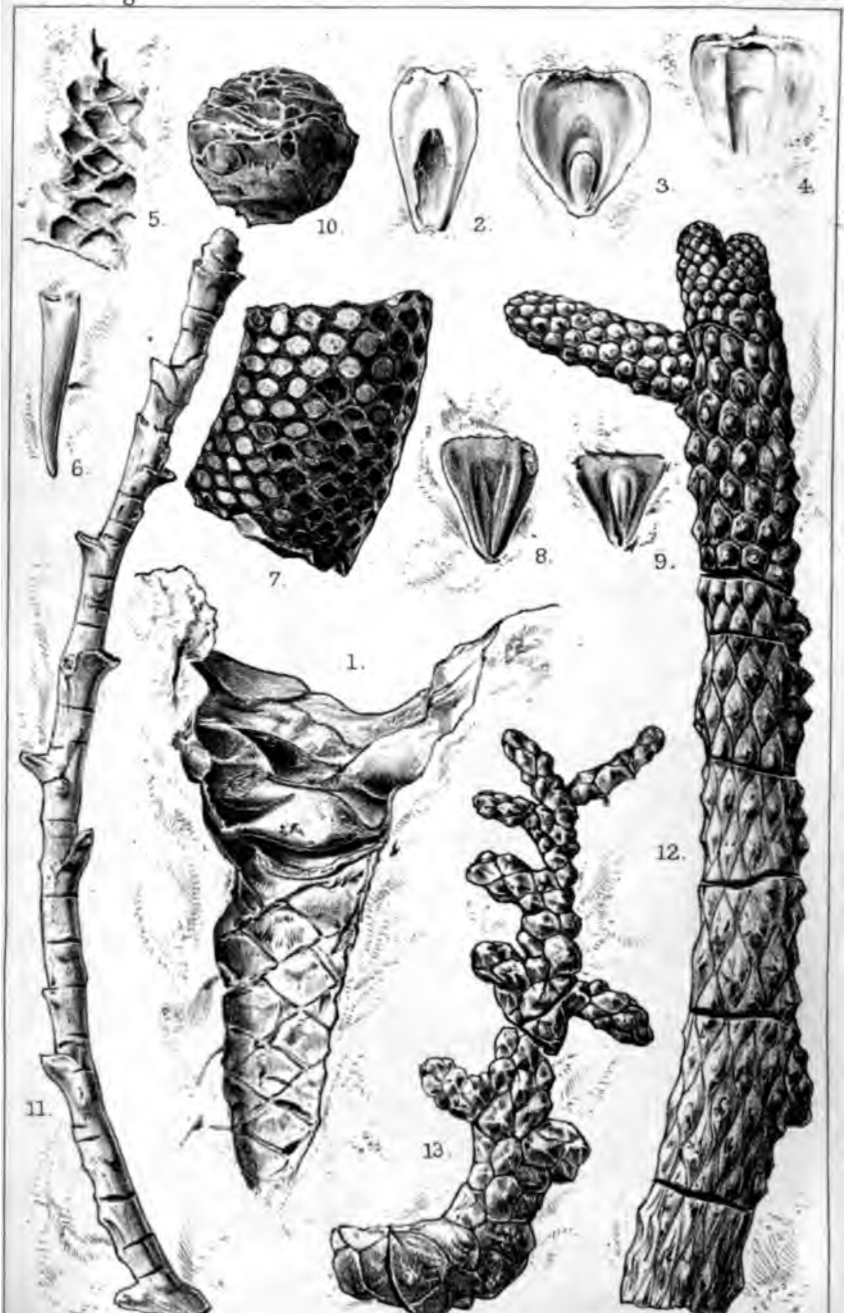

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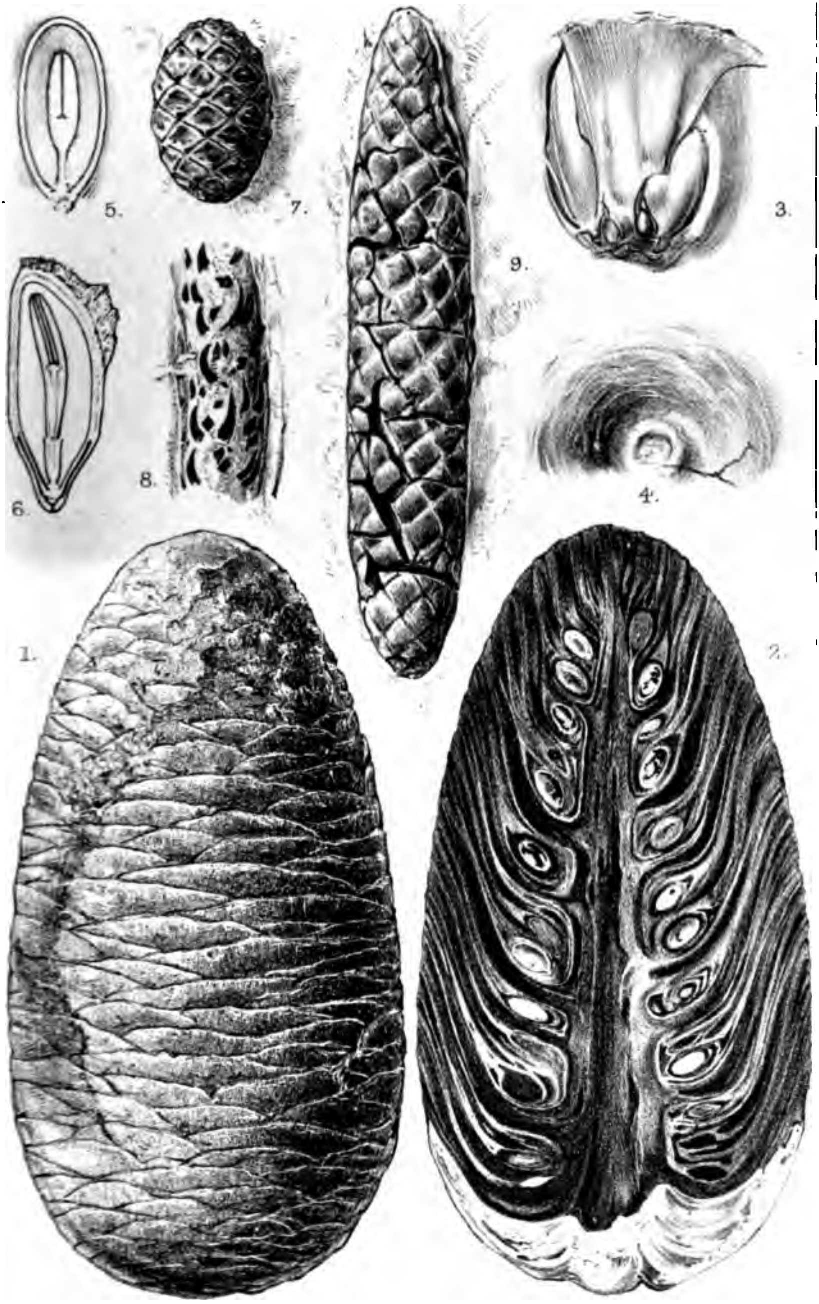

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Coniferous Fruits from Secondary Rocks

THE
GEOLOGICAL MAGAZINE.

No. LV.—JANUARY, 1869.

ORIGINAL ARTICLES.

I.—On some Undescribed Coniferous Fruits from the Secondary Rocks of Britain.[1]

By Wm. Carruthers, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATES I. and II.)

I. Pinites, *Witham*.

In the paper on Coniferous Fruits I described in detail the structure of three cones which had originally been described as, and all along believed to be, Cycadean. These cones were *Zamiostrobus macrocephalus*, Endl.; *Z. ovatus*, Göpp; and *Z. Sussexiensis*, Göpp. In making, in June last, a careful comparison between the version of M. Brongniart's important essay, "Exposition Chronologique des Périodes de Végétation et des Flores diverses qui se sont succédé a la surface de la Terre," published in the *Dict. univ. d'Hist. Nat.* 1849, and the version in the *Ann. des Sc. Nat.*, Ser. III., Vol. xi., p. 285, bearing the same date, but which evidently, from the occasional emendations, had had a careful and later revision by its learned author than the copy with which I had heretofore been working, I found that M. Brongniart had already referred two of the species to the genus *Pinites*. On a foot-note on pp. 317, 318 of the volume quoted he gives the following reason for this change: "Un échantillon de ce fruit (*Zamiostrobus macrocephalus*) qui vient de m'être communiqué par M. Wetherell, établit d'une manière bien positive que ce n'est pas un fruit de *Zamia*, mais un cône de *Pinus* ayant tous les caractères de ce genre, relativement à la forme et à la direction des écailes, et à la position des graines géminés a leur base. Quant au *Z. Sussexiensis*, son analogie avec le précédent me paraît évidente." To M. Brongniart then belongs the credit of having first correctly determined the affinities of these two cones, and they must be quoted as *Pinites macrocephalus*, Brongn., and *P. Sussexiensis*, Brongn.

To the species already recorded of this genus, I have to add two new and striking species from Cretaceous Rocks, and a third from the Upper Oolites.

---

[1] This paper is supplementary to two papers published in Vol. III. of the Geol. Mag.; the one "On Araucarian Cones from the Secondary Rocks of Britain," at page 249; and the other "On some Fossil Coniferous Fruits," at page 534.

1. PINITES LECKENBYI, *sp. nov.* Plate I. Figs. 1-5.

Cone oblong-ovoid, with an obtuse or subtruncate apex; scales very broad, not thickened at the apex; seeds small ovoid.

Locality.—Lower Greensand of Shanklin, Isle of Wight.

This beautiful cone forms part of the collection of John Leckenby, Esq., F.G.S., Scarborough. It is preserved in its original form, and so perfectly fossilised, that the various details of its structure can be determined as satisfactorily as in a recent cone. It is 4 inches long, and 2 inches broad. There is still attached to it a portion of the branch which supported it, represented on Fig. 4. The structure of the interior, as disclosed in the longitudinal section (Fig. 2) agrees in every character of importance with that of the cone of *Pinus Cedrus*, Linn. The scales are marked with parallel striæ, curving upwards and outwards from the base (Fig. 3). Several of the seeds exhibit the embryo in the centre of the albumen, and in one the section is so made as to show the divisions of the Cotyledons (Fig. 5). That this structure may be the better understood, I have placed beside it on the Plate a copy (Fig. 6), from Richard's *Memoire sur les Conifères*, (pl. 14, fig. H,) of a section of the seed of *Pinus Cedrus*, Linn.

The affinity between this cone and the recent cedars is so obvious, that it would be wasting words to dwell upon it; but it may be interesting to remark that this group of pines, which is confined, according to Parlatore in his recent Monograph of the Coniferæ,[1] to two species, the cedar of Lebanon and the Deodar, formed a striking characteristic of the Cretaceous flora. Besides the species just described, two others have been found in our British rocks, *P. Benstedi*, Endl., and *P. oblongus*, Endl.,[2] both from the Lower Greensand. Another species, *P. Corneti*, Coem., forms part of that remarkable local flora of Cycads and Conifers of Cretaceous age, described by M. Coemans, from La Louvière.

2. PINITES GRACILIS, *sp. nov.* Plate I. Fig. 9.

Cone elongated, cylindrical, tapering at the extremities into somewhat acute ends; apex of the scale rhomboidal, somewhat thickened.

Locality.—The Gault of Eastware Bay, near Folkestone.

I am indebted to J. S. Gardner, Esq., F.G.S., for my acquaintance with this cone. He has two specimens in his collection. They are 3½ inches long, and ¾ of an inch broad. The cone is singularly different from any species, recent or fossil, with which I am acquainted.

PINITES DEPRESSUS, *sp. nov.* Plate II., Fig. 10.

Cone small, cylindrical, depressed at the apex; scales short, very broad, thin at the apex.

Locality—Kimmeridge Clay of Weymouth.

The materials for establishing and describing this species are somewhat imperfect; but as this is the only coniferous fruit yet recorded from the Kimmeridge clay, and as it is a well marked, though probably a young cone, it seemed to be desirable to figure it. It is 10 lines long, and 11 lines broad. It is in the collection of the British Museum.

---

[1] De Candolle's Prodromus. Vol. xvi., Sec. 2, p. 407. *Paris*, 1868.

[2] The original and as yet only known specimen of this species is in the Museum at Oxford.

II. ARAUCARITES, *Unger*.

Since the publication of my paper on Fossil Araucarian Cones (GEOL. MAG., Vol. iii. p. 249), I have had the opportunity of examining the as yet unique specimen of *Araucarites Pippingfordensis*, Carr., with which I was then acquainted only from Fitton's accurate figure. This examination has confirmed the opinion I then formed that this fossil was nearly allied to *A. sphærocarpus*, Carr., and that they both belonged to the section represented by the Australian species, which, from their peculiarities, have been separated from the American species by some authors as a distinct genus with the name *Eutacta*. I may also mention here that unwittingly I introduced an *i* into the specific name, which should not be there, following the erroneous spelling of Unger's *Synopsis*.

I have now to add two additional species belonging to this genus, both from Oolitic rocks; founded principally on the detached scales which occur, the one in great abundance at Stonesfield, and the other somewhat more rarely in Yorkshire.

1. ARAUCARITES BRODIEI, *sp. nov.* Plate II. Figs. 1–6.

Scales from the centre of the cone cuneate, gradually tapering towards the narrow base of attachment to the axis, composed of two portions, each terminating at its free apex in a short spinous process, the lower and larger portion very broad and membranous, the upper portion narrower and somewhat parallel-sided, supporting between them a single ovoid seed.

Locality.—From the Stonesfield Slate of Stonesfield.

I first noticed this species when examining the large collection of Stonesfield slate fossils in the Oxford Museum, and part of my illustrations are from a specimen which Professor Phillips permitted me to have the loan of from his private collection. The scales are scattered over the surface of the slate, exhibiting, as is the case with the fossils of this bed, only casts of the organism slightly coloured with the remains of the mineral carbon into which they were converted. In some specimens the cast of the three parts of the scale are clearly seen, viz., the upper and under scales and the seed. The scales are from eight to eleven lines long, and from six to twelve lines broad at the widest parts. They present the double apex characteristic of the section *Eutacta*. In the collection of the Rev. P. B. Brodie I have found the cast of the lower portion of a cone, with an inch and a half of the supporting branch, marked by the scars of the leaves. This fragment exhibits the attachment of eight scales, and clearly establishes the true nature of the detached specimens. This is the more important, as the scales have been described as complete organisms by M. Pomel,[1] who has detected them in the

---

[1] Amtlicher Bericht über du xxv. Versammlung der Gesellschaft Deutscher Naturforscher und Aerzte in Aachen, Sept., 1847, pp. 347-352.

Jurassic rocks of St. Mihiel and De Seyssel in France. He thus describes the specimens and interprets their meaning:—"The most remarkable of these organs are the ovate-lanceolate scales, which thin towards their apex, and have an oblong cavity hollowed out of their upper portion for the reception of an oblong somewhat compressed seed. The similarity in the form of their impressions show that they were really more or less foliaceous scales. If the apex is mistaken for the base they might be taken for the detached scales of an *Araucaria*. But in examining a number of these scales it becomes evident that the enlarged end is the base, because of its concavity, 'et en outre elle est toujour accompagnée d' une autre empreinte en portions de cercle, large mais courte et se terminant évidemment par un court onglet.' The thickness of this impression indicates that the fossil was a strong scale on a large spathulate leaf, upon which was inserted the carpillary scale,—the whole being certainly borne at the termination of a branch. This forms the whole female organ, and exhibits a great analogy to the fruit of *Taxineæ*,—to that of *Dacrydium* for example, which is in the same way borne on a terminal thickened and dilated leaf. The discovery of a fragment of a branch terminating in one of these carpillary scales dispels all doubt as to this interpretation of their structure. They were then *Taxineæ*, but without drupaceous fruits, the ovule being enclosed in a true and not fleshy scale. They form a small extinct family near *Taxineæ*, which may be called *Lepidocarpeæ*. The male buds are ovoid, or cylindrical-oblong, and are composed of scales more or less broad at the base, recurved at the apex, and loosely or compactly imbricated. Traces of stamens can be detected on the scales, probably coriaceous and thick, but their characteristics cannot be clearly determined."

After examining the various species of Conifers of Oolitic age, based as they are chiefly upon the foliage, he concludes that there is no reason for placing them in separate genera, and he consequently establishes a new genus *Moreauia*, rejecting all the names hitherto employed, because, with a single exception, they suggest false analogies, and that excepted name (*Brachyphyllum*) is applicable only to a section of the whole. He describes eight new species from the French Oolites, and places 25 other species in his genus, most of which have been long known under the names *Brachyphyllum*, *Thuites*, *Cupressites*, *Araucarites*, *Lycopodites*, *Cunninghamites*, *Taxodites*, and *Taxites*. M. Pomel promises a more complete justification of his views in a monograph of the genus shortly to be published, but which, as far as I have been able to ascertain, has not yet made its appearance.

I have quoted M. Pomel's observations at length, as they are, if they can be established, most important, inasmuch as they introduce to science a new and singular tribe of extinct Taxineous *Coniferæ*. Genera established upon foliage are at the best unstable, and affinities determined only on such materials are nearly always unsatisfactory. There need, then, be no insuperable barrier to the union of all these various forms in a single genus, if the organs of reproduction were found to be similar. That genus would indeed be very variable in its foliage if it included such forms as *Brachyphyllum* and *Cunninghamites*, but a wider variation is known in the very natural genus *Podocarpus* among living *Coniferæ*. M. Pomel maintains that the organs of reproduction are the same; but that opinion rests only on the observation, as he believes, of a single specimen of the connection of foliage and fruit, in one of his 33 species; and in maintaining this position he is obliged to set aside the observation of M. Brongniart in regard to the fruit of *Taxites podocarpoides*, Brongn. In the numerous examples from the Stonesfield slate which have passed under my observation I have not met with a single specimen which would support M. Pomel's opinion. If the conditions of the St. Mihiel rocks are similar to what exists at Stonesfield, as appears from M. Pomel's descriptions, every one acquainted with our English rock must know how easy it is to be deceived in attempting to unite fragmentary fossils from mere juxtaposition of impressions which does not in the least testify to former organic connection.

The structure of the scales as exhibited in the better preserved specimens, places it beyond doubt that M. Pomel has mistaken the apex for the base of the organism. The apex of the scale is double, each portion representing one of the two structures of which the Araucarian scale is composed, and which can be easily distinguished in numbers of the specimens. Each of these portions terminates in a short free spinous process. It would be quite anomalous to have such a double attachment for a single fruit. Taking, however, the interpretation I propose, everything is intelligible,—the form of the scale, the position of the seed, the broad membranous wings to the scale, and the double apex, all agree with what occurs in the Australian species of *Araucaria*, and with what I have shown to be the structure of *Araucarites sphærocarpus* (Geol. Mag., Vol. III., p. 252), And that this is the true interpretation of the scales is established by the cast of a fragment of a cone from the Rev. P. B. Brodie's collection figured on Plate II., Fig. 1.

There is a considerable variety in the size and form of the scales scattered over the surface of the slate, but they all agree in bearing a single seed, and in having a more or less extended membranous margin to the scale. The difference in form may indicate the existence of more than one species, but I am rather inclined, from the materials I have examined, to consider it due to the position on the cone which the different scales occupied. Figures 3 and 4 represent the most abundant found; specimens occur considerably larger than those figured; Figure 2 is a form of which I have several examples. Except that the scales of *Araucaria excelsa*, the species found on Norfolk Island, are considerably larger than those of the fossil, they agree remarkably in every other respect with them.

In explanation of the occurrence of so many separate scales, and the rarity of cones, it deserves to be remarked that, unlike the cones of our northern *Abietineæ*, the scales very readily separate from the axis in *Araucaria*, so that it is difficult to preserve them whole in collections.

Impressions of two fragments of branches have been seen by me in the Stonesfield slate, which most probably belonged to this species (both in the collection of the British Museum), of one of which a portion is figured on Plate II., Fig. 5.

I have also observed a leaf agreeing in the size of its base with the scars on the branches, and in form with the leaves of some living species of *Araucaria*. It is represented at Figure 6 of the same Plate.

2. ARAUCARITES PHILLIPSII, *sp. nov.* Plate II. Figs. 7–9.

Scales from the centre of the cone cuneate, nearly as broad as long, lower scale thickish throughout, without membranous wings.

"Winged seed," Phillips' Geology of Yorkshire, ed. I. (1829), p. 190, plate x, fig. 5.

Locality.—Inferior Oolite or Lower Calcareous Sandstone shales (Phillips) of Yorkshire.

Professor Phillips observed these scales in the beds at Haiburn Wyke. He was evidently unable to determine to his own satisfaction what they were, and so modified his first suggestion that they were probably the seeds of *Cycadites*, at page 150, to the more general designation, "Winged seed," at page 190.

When I detected the species just described in the Oxford Museum, Prof. Phillips drew my attention to the similar organisms from Yorkshire. They are smaller in size than the species just described, being from six to eight lines long by about six lines broad. The structure of the scale, with its single median seed, although not so clearly exhibited as in the casts of specimens in the Stonesfield slate, is sufficient to show, without any doubt, that it is an Araucarian scale. Additional evidence confirming this opinion is obtained from a fragment of a cone in the collection of Prof. Williamson, of Manchester, and which he has been good enough to let me have for the purpose of figuring it. This specimen (Fig. 7) is a portion of a rubbed cone, imperfect at both extremities, with the scales abraded to near the axis, showing the cavities which held the seeds, and these are filled on one side of the cone with carbonate of lime, which takes the form of the seed it has replaced. Each scale bears a single seed, as in *Araucaria*, and the size of the scale and the seed corresponds with that seen in the detached scales. As this fragment is from the same deposit as the scales, it may fairly be concluded that it is the cone of *Araucarites Phillipsii*. It shows it to have been smaller, more cylindrical, and to have been composed of smaller, shorter, and more broadly cuneate scales than *A. sphærocarpus*, Carr., found in beds of the same age at Bruton, Somersetshire.

Professor Phillips figures the apex of the scale terminating in a single short apiculus. I have not been able to detect this, but the mineral condition of the specimens, and the shale in which they are preserved, make it difficult to determine clearly minute points in their structure. It is probable from the apparent absence of the double apiculus to the scales, and the want of the membranous wings, that this species may belong to the section of the genus named *Colymbeia* by Salisbury, and confined among living plants to the species inhabiting South America.

Setting aside the unsatisfactory evidence of foliage and wood, we know, from the remains of fruits of the existence of five species of *Araucaria* in the Secondary rocks of Britain. One Cretaceous *Araucarites Pippingfordensis*, Carr., from the Wealden, and the others Oolitic, one undescribed and apparently lost, but determined by Robert Brown, from the Purbeck, one *A. Brodiei*, Carr., from the Stonesfield slate; and two *A. sphærocarpus*, Carr., and *A. Phillipsii*, Carr., from the Inferior Oolite.

SEQUOIITES GARDNERI, *sp. nov.*, Plate I, Figs. 7, 8.

Cone oval, scales peltate, the rhomboidal apex, smooth, depressed in the centre, broader than deep; leaves falcate, incurved, subquadrangular in section, arranged spirally on the branch.

Locality.—The Gault of Eastware Bay, near Folkestone.

For this second British Cretaceous species of *Sequoiites* I am indebted to J. S. Gardner, Esq., whose researches in the Gault of Folkestone I desire to acknowledge by associating his name with the species.

APPENDIX.—The remarkable branches from the Oxford Clay which are represented by Figures 11–13 of Plate II. are placed there with the view of eliciting information regarding them, rather than for the purpose of adding names and descriptions, which mean nothing, to the already long list of uncertain objects that occur in every enumeration of fossil plants. Both forms—that of Figure 11, but especially that represented by Figures 12 and 13—are very remarkable, and easily recognisable. It would specially help to a satisfactory determination of the true nature if either foliage or fruit could be found associated with them.

EXPLANATION OF PLATES I. AND II.—PLATE I.

FIG. 1. *Pinites Leckenbyi*, Carr.

2. Section of the same through the axis; the scales and the seeds. The section is not continued to the base of the cone, the lower and lighter coloured portion being fractured.

3. A scale with two seeds at the base.

4. A portion of the base of the cone seen from below, and exhibiting the remains of the supporting branch.

5. Section of one of the seeds considerably magnified, showing the embryo, in the middle of the albumen, with the division of the Cotyledons.

6. Section of a seed of *Pinus Cedrus*, Linn., for comparison with Fig. 5. From Richard.

7. Cone of *Sequoiites Gardneri*, Carr.

8. Fragment of a branch of the same.

9. Cone of *Pinites gracilis*, Carr.

PLATE II.

FIG. 1. Cast of the fragment of a cone of *Araucarites Brodiei*, Carr., with a portion of the supporting branch.

2, 3, and 4. Scales of the same; the latter two exhibiting the double nature of the apex.

5. The cast of a fragment of a branch, and

6. A leaf, probably, belonging to the same species.

7. Rolled fragment of *Araucarites Phillipsii*, Carr., showing the single seed in each scale.

8 and 9. Scales of the same species.

10. Cone of *Pinites depressus*, Carr.

11. Branch from the Oxford Clay of Chippenham, Cambridgeshire.

12 and 13. Branches from the Oxford Clay of Christian Malford, Wiltshire. 12 from the collection of Wm. Cunnington, Esq., F.G.S.; 13 from the British Museum.

II.—SUGGESTIONS AS TO GEOLOGICAL TIME.

By J. CLIFTON WARD, F.G.S., of the Geological Survey of England and Wales.

BUT a few years since geologists were in the habit of drawing largely from the Bank of time, and the more they drew the greater was the supply they seemed to want, till at last the thought seemed to come quite natural to them that the supply indeed was inexhaustible. Quite lately, however, these time-speculators have had it suggested to them that there is a limit to the supply, and that the countless ages on which they have depended seem to be very probably but some one hundred millions of years, and untold ages to be reckoned by telling numerals.

Just as, however, it would be doubtless a fault in geologists to look up to mathematicians as infallible in the results at which they arrive regarding geological phenomena, so is it unwise to accept for granted the explanation of like phenomena from a cosmical point of view without first putting it to every possible geological test. Now Mr. Croll has very clearly shown that 240,000 years ago our earth was so situated as regards the eccentricity of its orbit, and the position of its northern hemisphere during the summer and winter solstices, as gradually to bring on a glacial climate, lasting until some 80,000 years ago, though having two or more warm periods included within this term of 160,000 years.

Can any geological facts be brought forward to test this theory?

Now it seems to me that there are but two classes of facts which can be of use in such an investigation, viz.:—

1st. The building up, or wearing away and deposition, of solid material.

2nd. The rising, or falling, of the earth's crust.

Under the first class of facts—1st. Building up. Suppose a Coral-reef 1000 feet in thickness to be formed on a spot where the refrigerating effects of the glacial climate must have prevented the existence of reef-builders during that epoch, and that such reef presents every appearance of continuity of growth; then, provided we can form an estimate of the average growth of such a reef under favourable conditions, the *least* time required may be calculated: for instance, taking one foot per century as the rate of increase in vertical height, a reef 1000 feet in thickness would take at the least 100,000 years in forming, and we should conclude that the Glacial period must have ended not *less* than 100,000 years ago.

2nd. Wearing away and deposition.—Sand and clay to a thickness of some 60 feet is found lying upon Glacial Drift, or surrounding and partly overlapping mounds of such drift, as, for example, in the neighbourhood of York. In the artificial process of warping, each tide not unfrequently deposits about 1-12th of an inch of fresh soil. If comparisons could be made between the natural and artificial methods of warping, the difference in area being allowed for in the two cases, some sort of conclusion might be arrived at as to the length of time that the materials for 60 feet of warp took in being denuded from one spot and deposited in another, such a period being the least which could have elapsed since the deposition of the Glacial Drift.

Under the second class of facts, which is, perhaps, less reliable, we may reason thus:—

1st. Elevation.—All observations tend to show that the elevation or depression of the earth's surface takes place very gradually, and extends with tolerable constancy over long periods (this the thick coral-reefs of the Pacific seems to prove); supposing we are able to conclude generally that this movement averages one foot per century over many parts of the earth, then marine Glacial deposits now 1000 feet above the sea would show that they were formed not less than 100,000 years ago.[1]

2nd. Subsidence.—The case of the Coral-reef in "building up" may also be taken as an example of subsidence within a given period. Now taking some actual examples let us see whether they, even roughly, lend any support to the results arrived at by Mr. Croll.

The Peninsula of Florida is made up of some ten coral-reefs one within the other. The whole Peninsula, being only 16 or 17 feet above the sea-level, is formed of the same species of coral, that species being still at work in forming the outermost reef, between which and the Island of Cuba the Gulf Stream flows. Professor Huxley, calling each reef 70 feet thick, and taking the upward growth as one foot per century, has estimated the period for the growth of one reef as 7000, and for the whole Peninsula as 70,000 years, supposing the conditions necessary for a constant increase in height of the reef to be favourable.

Dr. Dana, in his excellent Manual, divides the Post-Tertiary Period into the following Epochs:—Glacial Epoch, Champlain Epoch, Terrace Epoch.

The Glacial Epoch includes the true Glacial Drift, a deposit due to a vast spread of land-ice reaching down to the latitude of 39°, the epoch being one, Dr. Dana considers, of high latitude elevation.

A partial subsidence of the country brought in the Champlain Epoch, softening the climate, melting the vast ice-sheet, swelling the rivers, and causing great thicknesses of fresh-water deposits to be formed along their course and around the large lakes. The shells in these deposits indicate a temperature very similar to the present. During the Terrace Epoch the land was again gently elevated, the elevation being greater in high latitudes—as much as 1000 feet in the extreme north—and lessening southwards, where probably the upward movement was completely lost; then it was that the Champlain deposits were carved into terraces, and sea beaches left high and dry.

But to return to the Glacial Epoch: if North America was clad with one universal sheet of ice down to the parallel of 39°, it would certainly have been impossible for coral-animals to have been reef-building only 9° farther south. From this one would argue either that the reef-builders of Florida began their work before the Glacial Epoch, left it off as the climate became cold, and resumed it at the close of that period, or that the whole structure was of Post-glacial age. If the former was the case, it would seem probable that there might be some indication of it, either in a change of species, or in some more or less marked break in the structure of the Peninsula. I believe there is no such indication; therefore the evidence would lead one to conclude the whole structure to be Post-glacial, and we have already seen that probably the work cannot have taken *less* than 70,000 years. But if the cold of the Glacial Epoch could arrest the labour of the reef-builders at this particular part, it probably had a similar effect upon other parts likewise. The sheet of ice upon Greenland is acknowledged to have a great effect in cooling our climate at the present time; its removal would have, as Mr. Croll says,[1] quite a "magical effect upon the entire northern hemisphere:" imagine, then, the power that a sheet of ice occupying the greater part of the northern hemisphere would have in cooling those portions of the globe immediately south of it. There is, however, another point to be considered, viz., that according to Mr. Croll's theory the causes which would in the northern hemisphere produce an extremely cold climate, would in the southern produce a proportionally hot one; the hot southern hemisphere, however, would have its climate more influenced by the cold of the northern, than the northern would have its cold climate affected by the heat of the southern;—therefore the heat would have to retreat as it were before the cold, and the probability is that instead of the hottest part of our globe being situated around the equator, it would lie considerably south of it. In this way the two isotherms of 68°, which are the limits of reef-builders at the present day, would be carried considerably south of their present position, and Coral-reefs would then probably only be in process of formation south of the equator. But do not Coral-islands in mid-ocean, with deep water all around, indicate a continuity of upward growth? For suppose an island in the Pacific north of the equator, rising 1000 feet above the sea, to be encircled by a reef; if the land sink at the same rate as the corals can build, say one foot per century, the reef will grow upwards, the island lessening in diameter. But now suppose a Glacial climate in the northern hemisphere to come on and seriously to affect the reef-builders, they must of necessity die off, migration being impossible by reason of the deep surrounding sea. The subsidence of the land, however, would probably continue, and when the cold was over and the reef-builders might have found it possible to continue their work, there would be no means for them to gain the shores, and the island would go down without leaving an atoll behind as tombstone to mark the spot of its watery grave.

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[1] Example—The marine shells at an elevation of 1400 feet at Moel Tryfaen, near Bangor; for even if the hypothesis of a 600 feet fall in the sea-level be true, the land must have been raised 800 feet, giving a period of 80,000 years at the rate of one foot per century.

Supposing, then, the Glacial climate had a marked effect upon the reef-builders north of the equator, it would be impossible for any of the reefs we now see in that region, surrounding or taking the place of oceanic islands, to have been commenced before the Glacial Epoch. Let the accompanying woodcut represent the outline of the great Pacific Continent; the line A B is the sea level soon after the commencement of the Glacial Epoch, say 240,000 years ago; suppose the land to be regularly sinking at the rate of one foot per century, in 160,000 years (the close of the Glacial Epoch) the sea-level would be represented by the line C D, the distance *x y* being 1600 feet in vertical height. During this interval, however (according to our supposition), the reefs 1, 2, 3 north of the equator would have ceased to grow upwards, while the reefs 4, 5, 6 south of it would have continued their upward growth; after this period of 160,000 years the reef-builders would be able to recommence work north of the equator, and No. 4 reef might gradually extend itself further north (in the direction of the arrow) until the Post-glacial reef No. 7 would commence and finally form with No. 4 one great encircling reef; but owing to the great depth of ocean which would now separate G from H no reef-builders could find their way to the island G, which would, although other conditions were favourable, be without a reef of any kind; and in some instances it might be the case that the reef 4 would not be able on account of the deep water to wrap round the north side of the sinking island, and in this way some of the strange forms of reefs may be occasioned. The line E F represents the sea-level as it now is after a lapse of 80,000 years, the distance *x′y′* representing 800 feet in vertical height. We should thus expect to find in the Coral regions north of the equator some islands without reefs of any kind, others with encircling reefs, or atolls of no very great thickness, and therefore small size.[1] This view is somewhat confirmed by the fact that the atolls of the Pacific "diminish towards the equator and disappear mostly north of it;"[2] and I believe I am correct in stating that the *thickest* reefs, so far as can be ascertained with any accuracy, occur mostly south of the equator. Dana estimates the whole subsidence in the Pacific area to be not less than 6000 feet, and adds,[2] "It is probable that this sinking began in the Post-tertiary period." Now, since it seems likely that the general rate of subsidence cannot be much more than a foot per century, in order that the corals may keep pace with it, the sinking of this 6000 feet of land would take 600,000 years,

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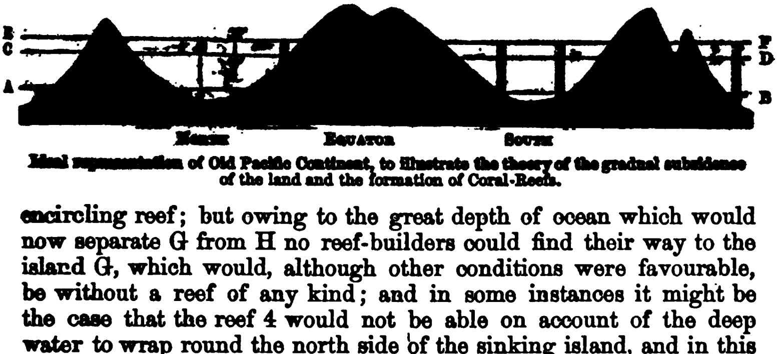
[1] Article in Philosophical Magazine for November, 1868.



Ideal representation of Old Pacific Continent, to illustrate the theory of the gradual subsidence of the land and the formation of Coral-Reefs.

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[1] Of course the thicker a reef is the larger will be the area which it includes. If Darwin's chart of Coral-Rocks be referred to, it will there be seen that north of 10° north lat., there are but one or two small atolls, while in the southern hemisphere they extend in mass as far as the parallel of 25°.

[2] Dana's Manual of Geology, p. 587.

going far beyond Mr. Croll's Glacial period; and it seems to me very possible that the subsidence commenced long before the Post-tertiary, the continent about the commencement of the Glacial Epoch having reached a condition somewhat similar to that represented in the figure where the highest point might be some 3000 feet.

The following is an actual example of the wearing away of solid materials since a given period. The Falls of Niagara have been cut back at least six miles since the Champlain Epoch, for lake-deposits formed by the old extension of Lake Ontario, and containing similar shells to those now living near the entrance of the lake, are found both at Goat Island and on either side of the gorge near the whirlpool; six miles then at least of the gorge have been excavated since the formation of these deposits. Dana says,[1] "Taking the rate at one foot a year, the six miles will have required over 34,000 years; if at one inch a year—which is 8⅓ feet a century—380,000 years." The former was Sir Charles Lyell's estimate, which, if considered too great, is probably outdone in the other extreme of one inch a year; if, however, we take the mean of these two estimates, namely, six inches a year, the time would then be 62,000 years since the probable close of the Champlain Epoch.

Going still further north in the same quarter of the globe, raised beaches of Champlain Epoch age are found in the Arctic regions at an elevation of 1000 feet above the sea;[2] if it be not far from the truth that the probable average rate of elevation as well as depression is about one foot per century, then 100,000 years would seem to have elapsed since the Champlain Epoch, instead of some 60,000 as just estimated. But is there any good reason to think that the average rate of continental elevation (I speak not of local and paroxysmal elevations connected with volcanic phenomena) is the same as that of depression? It seems to me probably not; for take the case of the west coast of South America, which has undergone within comparatively modern times an elevation of at least 1200 feet; if we suppose that the elevation of one large tract is connected with the subsidence of a neighbouring tract, and we take into consideration that for the most part the highest portions of continents face the largest seas, and are generally not far removed from the coast line,[3] then in the case of South America, for instance, we see why the Andes on the west coast should be at a greater elevation than those ranges on the east of the same continent. Inasmuch also as the tract over which elevation has taken place is far less than that over which subsidence has been going on (supposing elevation on a large scale to be due to the sinking of certain portions and the squeezing up of the portion between them), it follows that the elevatory force having to act within narrow limits will produce a greater upward effect than the subsiding force, acting over a larger area, will produce in a downward direction. Thus, supposing the subsidence of the great Pacific area to be connected with the elevation of South America, it might be that while the former sank some 6000 feet, the latter would rise some 12,000. Sea-areas are for the most part areas of depression, and land-areas those of elevation, but the proportion of water to dry land is as eight to three: consequently elevating force is confined to less than half the space of depressing force; therefore it ought to act through more than twice the height. If such a theory be at all correct, then the case of a 1000 feet elevation in the Arctic regions since the Champlain Epoch might be accomplished in some 50,000 years.

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[1] Manual of Geology, p. 590.
[2] Dana's Manual, p. 551.
[3] Dana's Manual of Geology, p. 731.

It thus seems that the Coral-reefs of Florida probably took not less than 70,000 years in forming, their commencement dating from soon after the close of the Glacial Epoch; that the Niagara gorge may have taken some 60,000 years in being cut out since the close of the Champlain Epoch of North America; that the elevation of the beaches belonging to the Champlain Epoch in the Arctic regions may have been accomplished in some 50,000 years; and that the elevation of the Glacial-marine deposits of Moel Tryfaen to the height of 1400 feet may have taken some 70,000 years.

I regard the foregoing examples as very rough indications of the method that will probably have to be pursued by geologists to test the periods of geological time as deduced from cosmical causes.

III.—Note on the Passage of the Red Chalk of Speeton into an Underlying Clay-bed.

By C. J. A. Meÿer, Esq.

The accompanying section represents the passage of the Red Chalk, of Speeton, into an underlying bed of dark slaty clay. It exhibits a small section, which was visible in the cliff on the South of Speeton Beck, in September last.

In Mr. Judd's excellent paper on the Speeton Clay,[1] much stress is laid on the *position* of the supposed *break*, or want of conformity, between the Upper Cretaceous and the Neocomian strata of the Speeton cliff, while, at the same time, it is freely acknowledged that the junction of the two formations has not been observed.

Now, it is evident from the accompanying section that the Red Chalk passes quietly downwards into a dark coloured clay. And it is also evident that this dark clay must represent, from its position, either Gault or Lower Greensand.

If it represents the Gault, Mr. Judd's suggestion respecting the position of the supposed break in the Cretaceous series at Speeton may be still confirmed.

If, on the other hand, the black clay represents the top of the Lower Greensand—as is not unlikely—a break in the series might still be *supposed* to occur at the base of a representative of the

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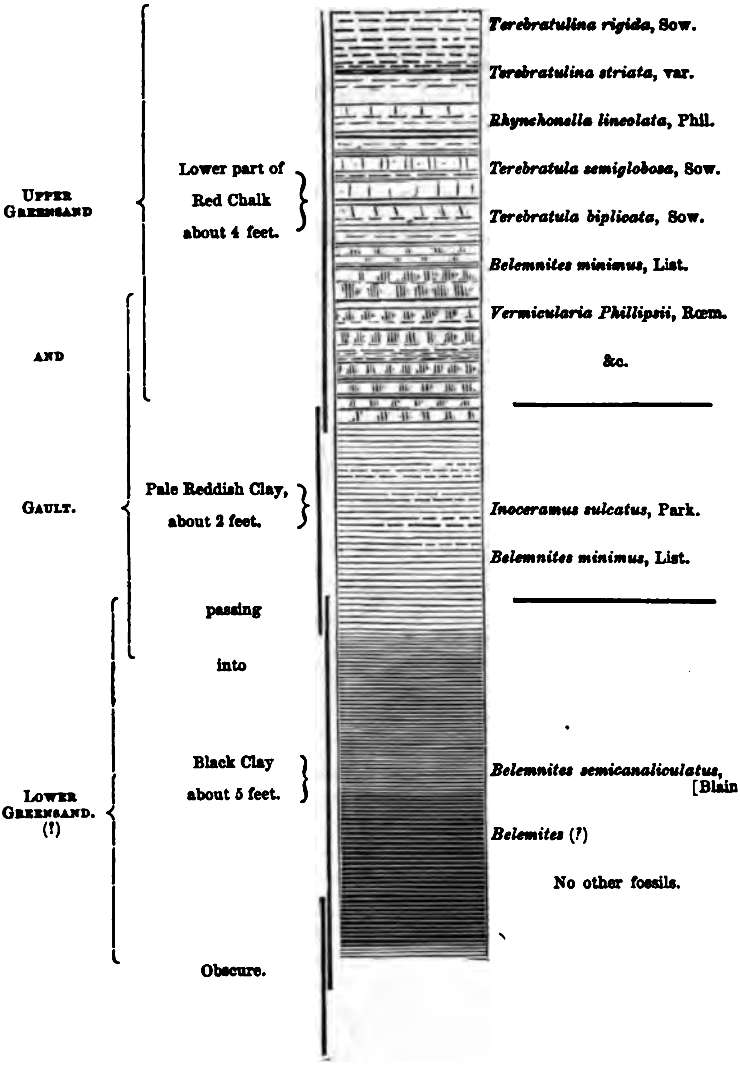
[1] On the Speeton Clay. By John W. Judd, Esq., F.G.S. Quart. Jour. Geol. Soc. vol. xxiv. p. 218.

“ Folkstone beds ” of the Lower Greensand. A supposition which, however well it would suit the views of the present writer, futur observation must decide.

DESCRIPTION OF CLIFF-SECTION SEEN ON THE SOUTH OF SPEETON BECK, IN SEPTEMBER, 1868.


UPPER GREENSAND
AND
GAULT.
LOWER GREENSAND. (?)
Lower part of Red Chalk about 4 feet.
Pale Reddish Clay, about 2 feet.
passing
into
Black Clay about 5 feet.
Obscure.
Terebratulina rigida, Sow.
Terebratulina striata, var.
Rhynchonella lineolata, Phil.
Terebratula semiglobosa, Sow.
Terebratula biplicata, Sow.
Belemnites minimus, List.
Vermicularia Phillipsii, Rœm.
&c.
Inoceramus sulcatus, Park.
Belemnites minimus, List.
Belemnites semicanaliculatus, [Blain
Belemites (?)
No other fossils.

IV.—The Lignite Bed near Cape Town, South Africa.

By James R. Gregory.

T the commencement of the present year some considerable interest was excited at Cape Town through the announcement the newspapers that coal had been discovered at the Cape, and onounced by reputed competent authorities to be of very good ality. Very soon afterwards it was reported, however, that it s not coal but peat, or lignite, and of bad quality; but still the wspapers persisted in calling it "The Coal diggings." I heard of discovery on my first arrival at Cape Town, in April last, and olved to visit the spot at the first opportunity. In the meantime btained some information, and also the name of the person who s superintending the working, and on April 24th went to the apmuts Station on the Cape Town and Wellington Railway, and lked across to the Joostenberg workings, about five miles from station.

I found on my arrival that a pit had been sunk to the depth of feet through a constant series of sands and clays, apparently of rtiary age. Whilst I was there, Mr. Thomas, who was superending the sinking, most obligingly measured and gave me the rious thicknesses of the different beds, which I subjoin: these re published some time afterwards in the newspapers at Cape wn:—

	FT.	IN.
Fine white sand	6	0
Black, or nearly black, very friable sandstone, highly bituminous	4	3
Lignite	1	2
Black highly bituminous clay	7	1
Soft bluish sand	1	0
Bluish friable sandstone	2	0
Loose blue sand	3	6
Mottled bluish clay	5	4
Red and bluish clay and sand	7	2
Red ochreous clay	3	6
White and yellowish mottled pipe-clay	15	0
Brown clay, like fuller's earth	6	8
Red and white mottled clay	4	9
Brown clay, like fuller's earth	3	6
Bluish clay	2	0
Purple or slate-coloured clay	1	6
Brown clay, like fuller's earth	2	6
Bluish clay	1	3
Brown friable sandstone	8	6
Purple or slate-coloured friable sandstone	2	9
Chocolate-brown friable sandstone	1	6
	90	11

Now as this lignite did not turn out to be coal, the Cape geologists, ho professed to have much knowledge of coal-mining as well as of erything else relating to minerals, suggested to dig deeper and eper till they came to coal; for as lignite was coal half-finished, al quite finished was certain to be found below. To go deeper is fortunately the idea with many persons unacquainted with coalining and the geological age of rocks. Now, by the table above, it will be seen that 80 feet 8 inches had already been sunk below the lignite and no coal had yet been arrived at. Mr. Thomas told me that he thought it likely he would soon get coal before he went much deeper. I told him positively that it was absolutely impossible to find coal anywhere in the neighbourhood, and that the lignite was a true Tertiary lignite, or brown coal, and in it I had found small fragments of the large fan-like leaves of the palm, similar to those in the Bovey coal in Devonshire, and which prove it to be of Miocene, or, at all events, of Tertiary age; and then the clays and sands evidently belong to the Tertiary Epoch, and are similar to our English deposits of pipe-clays and Eocene sands. In the bed of black friable sandstone, 4 feet 3 inches in thickness (and yet it can hardly be called a sandstone, as it is not compact enough), is a very large amount of a viscid petroleum-like substance which directly overlies the lignite bed, and the black bituminous clay immediately below it, and of a thickness of 7 feet 1 inch. I suggested that if these beds were of any extent they might be turned to account for making paraffin or some other oil, and used for burning; but then, again, it must be borne in mind that there is no fuel but wood in the district, and not a large quantity of that, so that some of the product must be employed to continue the manufacture: it is therefore doubtful if such an undertaking would pay.

In returning from Joostenberg I stopped at the D'Urban Road Station, where I heard that another bed of lignite existed: this is only about 12½ miles from Cape Town, Joostenberg being about 40 miles. This bed is about one mile from the station: here I found three small pits nearly full of water; the lignite appeared very similar, but perhaps in a little thicker beds than at Joostenberg, with the same variety of sands and clays, or nearly so. I think it may possibly be a continuation of the deposit at Joostenberg, though 25 miles distant.

Some short time after this I went on a journey up the country and heard nothing more of the "Coal diggings," till I accidently saw a notice in one of the papers that the works had been stopped,—and that they had dug 29 feet deeper since I was there, and then abandoned them, so that in addition to the beds in the above table the following have to be added:—

	FT.	IN.
Brown and red sandstone	9	0
Brown and blue sandstone	8	0
Yellow loose sandy rock	12	0
	29	0
In previous table	90	11
Total	119	11

In concluding this notice, I may just draw attention to the conduct of the newspaper editors. It seems that the English *Times* quoted or received notes of this "coal venture," which were inserted as a paragraph. After the speculation had been abandoned, the Cape papers turned round on the *Times* with a paragraph headed "Sold again. The London *Times* of such a date, etc., says that a coal-mine has been discovered near Cape Town, etc." If the Cape colonial newspapers were as particular as the *Times* and other London papers, there would not be so many "mare's nests" as the Capetonians are constantly discovering, and which usually end in smoke.

NOTICES OF MEMOIRS.

I.—Records of the Geological Survey of India. Vol. I. Part 2. August, 1868.

THIS publication contains miscellaneous notes and observations made by Officers of the Geological Survey of India.

Coal at Chanda.—Mr. W. T. Blanford, F.G.S., having been engaged in examining some coal seams discovered in the neighbourhood of Chanda, here furnishes a report on the prospects of the coal being profitably mined. He states that although one seam is very promising, some further research is necessary before a decisive opinion can be formed upon this subject.

Dr. Oldham adds that borings have been carried out close to the town of Chanda, and have proved the existence of coal, about 2 ft. 6 inches in thickness. The coal is said to be hard, but as no trial of it has yet been made, its quality is unknown.

Coal near Nagpur.—Mr. Blanford reports on the likelihood of coal being found near Nagpur. Although it is probable that the sandstones developed in the neighbourhood belong to the Indian coal-bearing series, yet he has been unable to obtain any indications of coal.

By far the greater portion of the beds of this series in Nagpur are concealed by thick alluvial soil, and it is therefore impossible to say whether coal exists beneath it, or not. Mr. Blanford, however, points out a few localities where its presence is just possible, in order that, if advisable, borings may be made to determine the question.

Geological Notes on the Surat Collectorate, (Bombay Presidency).—Mr. A. B. Wynne, F.G.S., gives a general account of the Physical features and of the formations constituting this Collectorate, and he then furnishes some detailed notes on the rocks in various localities.

Taken generally the district may be described as flat, with isolated hills on the south, and bordered on the east by a hilly and jungly tract.

The formations which occur are—

Recent	Cotton soil. Alluvium and river-beds.
Tertiary	Nummulitic
?	Trap.

The trap-beds consist of many varieties, ranging from solid basaltic trap to soft shaly-looking amygdaloid, the variously sized cavities of which are filled with zeolites of different kinds, and sometimes by transparent or amethystine quartz.

Resting unconformably upon the traps is to be seen a series of hard lateritic ferruginous rocks, coarse conglomerates, dull yellow earthy limestones, sandy and clayey beds; many of them highly fossiliferous, some largely made up of Nummulites, others of the separated valves of *Balanidæ*, with teeth of sharks, fragments of the carapaces of turtles, and bones as yet undetermined. From the evidence of the fossils, a 'Parisien' age has been assigned, by Dr. Stoliczka, to this series of beds. Sections of these Nummulitic beds, from one to three hundred feet in thickness, may be seen in many of the streams.

The alluvium is almost universally composed of a fine light-coloured argillaceous loam, seldom pebbly or gravelly, and always formed from the decomposition of the local rocks.

The cotton soil covers the alluvium over many large tracts of the country. It is often of considerable depth, presenting the usual desiccation cracks, but without any circumstances to throw additional light upon its source or formation. It seems in this country at least to result from the decomposition of an alluvium largely made up of trappean materials.

Cretaceous Cephalopoda of South India.—Dr. F. Stoliczka records some recent observations which must be considered as a supplement to his volume on the *Cephalopoda*, already published. No fresh materials have been procured, but from his having had last year the opportunity of examining, in London, Professor E. Forbes' original collection, made by Messrs. Kaye and Cunliffe, and also in different European Museums a large number of other species, with which Indian *Cephalopoda* have respectively been identified, new light has been thrown on some of the species, and some alterations in the names, etc., rendered necessary.

II.—The Jherria Coal-Field.

By Theodore Hughes, Assoc. R.S.M., F.G.S., [Mem. Geol. Survey, India, Vol. V. Art. 4.]

THIS memoir is confined chiefly to a detailed description of the physical aspect and geological history of an area of not less than two hundred square miles, and which has been termed the Jherria Coal-field. It occurs a few miles south and south-east of Parisnáth, one of the highest mountains in Bengal. The field commences at a distance of about 170 miles from Calcutta, and extends in an east and west direction about eighteen miles, its greatest breadth, in a line north and south, being about ten miles.

The character of the ground is generally flat, and nowhere rises into undulating scenery; it is rocky, and covered by a very slight amount of soil, so that cultivation is not extensively practised.

Two series of beds are developed in the district, the lower, the Talchir; the upper, the Damúda; comprising a total thickness of 6,800 feet of strata, and forming a basin, the beds usually dipping at right angles away from the boundary, at varying amounts, towards a common centre of depression.

The *Talchir* series consists of a Boulder-bed, and above it flaggy green shales and mammillated sandstones.

The *Damúda* series, which has three sub-divisions, is characterised by its containing coal. The bottom beds consist of felspathic grits, sandstone with seams of coal, carbonaceous shales, conglomerates, etc.; then come carbonaceous shales with ironstones, forming the middle sub-division; and at the top, thick-bedded, and yellow slightly calcareous sandstones. With the exception of the middle sub-division, coal occurs at all depths in the Damúda series.

The Boulder-bed of the Talchir series, which is, more properly speaking, a coarse conglomerate, consists mainly of masses of gneiss and quartz, of about one foot in length and three to six inches in breadth, imbedded in a matrix varying in texture from a coarse-grained sandstone to the finest silt. One is apt, at a first glance, to attribute to the agency of ice a share in the transportation of the larger blocks. But the author states that on examining the evidence he can find none to justify such an hypothesis. No scratchings or groovings occurred on any of the stones, nor have they been derived from any very distant source. The larger blocks sometimes retain the primitive form in which they were broken off from the parent mass. A recent visit to the Straits Settlements led the author to conclude that the beach deposit which is forming there at the present time is analogous to the so-called Boulder-bed.

No coal has as yet been discovered in the Talchirs. In the Damúda series the coal-seams appear to be very irregular, and to vary much in thickness. In the upper sub-division there is a general tendency to ignition in all the coal seams, owing, most probably, to the presence in them of iron pyrites, which gives rise to spontaneous combustion. Metamorphism is produced in the shales either above or below, and it is of a varied character. Sometimes the beds become like well-burnt bricks, or obtain a rough vesicular appearance.

A caking variety of coal is procured at one locality, which moreover gives out a copious supply of gas, burning with a rich yellowish white carburetted flame.

Many seams are much injured by the trap-dykes which ramify through them and render the coal useless. In one instance the coal assumes every variety of form and texture, passing from a light vesicular pumice-like stone through all the intermediate stages until it becomes a hard dense columnar mass.

The seams vary in thickness from a few inches to twenty feet, and more.

The quality of the ironstones is very poor, and they are so siliceous that even the native Kummars can do nothing with them.

In a note, appended to the report of Mr. Hughes, Dr. Oldham says, that if, in calculating the probable quantity of coal obtainable from this field, we take twenty feet as a fair average thickness of workable coal—the mean of all the sections drawn by Mr Hughes—and make allowances for the impersistence of the beds by supposing that they will extend over less than a third of the area of the field,—say sixty square miles, we should have an available supply of coal amounting to about 465 millions of cubic yards, or, roughly, tons.

But every such estimate must be of the rudest kind possible with reference to a coal-field, in which not a single pit has yet been sunk, nor a single opening made.—H. B. W.

REVIEWS.

I.—Thesaurus Siluricus—The Flora and Fauna of the Silurian Period. By J. J. Bigsby, M.D., F.G.S., etc., etc. London, 1868. Van Voorst. 4to. pp. 268. [Second Notice.]

(Continued from the November Number, p. 521.)

IN his introduction, Dr. Bigsby gives an analysis of the classes *Gasteropoda* and *Echinodermata*, and the orders *Trilobita* and *Brachiopoda* as they occur, both in stratigraphical and geographical distribution;—space, however, entirely forbids our attempting any fresh analysis for this notice, the subjects being so prolific. Under the head *Gasteropoda* in the introduction, pp. vii.-x., several tables are constructed; that on p. vii. gives the geographical summary of species for the chief areas in which Silurian life is known;—27 areas are given—12 on the American Continent, 3 in Britain (England, Ireland, Wales), 9 European, 1 South Australian, 1 Tasmanian, and 1 for North India; but in the chief and detailed summary, p. 169, in the body of the Thesaurus, 43 areas are given—25 American, 15 European, with India, Australia, and Tasmania in addition, and an analysis of all the genera (51) and 895 species, with their appearances, numbers, and habitations. The table (B) also containing those genera having the greatest range in time and space, with the number of species in each and number of countries inhabited—show a kind of analysis that may be carried to any extent. The result of one line for the *Pleurotomariæ* is, itself, suggestive. This genus contains 171 species, and they are distributed over 34 large countries [*the fossiliferous Silurian area of Canada alone is 70,000 square miles*]. This dispersion or distribution applies to all the 51 genera, and *species* belonging to the class *Gasteropoda*, the ratio of the proportion of species in each genus, and the different degrees of distribution being due to life habits, associated faunæ, sea-bottom, temperature, locality, etc. The Thesaurus tells us that 18 genera out of the 51 are known only in, and each confined to one district, and 12 of these genera possess only one known species in each, and 7 have 2 species only; supposing the genera to be well established, we only require further research, probably, to discover many other species. We have, however, much doubt as to the value of such genera as *Calyptræa*, *Cerithium*, *Delphinula*, *Littorina ? Naticella*, *Phasianella*, *Rotella*, *Siphonaria*, occurring in the Silurian rocks, until we certainly know more of them, and it is amongst such that the *few* forms, above named, seem to occur. We mention this to guard against drawing conclusions hastily upon doubtful determinations, as per centage in generic life is of importance on either side, and leads to false conclusions upon the question of *first appearance*, *locality*, etc., as propounded in the 7 doctrines laid down in the introduction to the Thesaurus. Particulars are given, in the body of the great table, of no less than 894 species of *Gasteropoda*. The increment and decrement of the *Gasteropoda* in time, as exhibited over large areas through their physical history and mutations, is one of the many problems which the Palæontologist is constantly called upon to investigate, and thus to account for the "rise and decline," "first appearance," and "extinction" of any group. Dr. Bigsby, at p. ix. (table C), points out in 8 subdivisions of the Silurian system, the rise, culminating point, and decline of the Silurian *Gasteropoda*;—their extinction, like that of other groups, which really took place at the close of the Silurian and commencement of the Old Red Sandstone, in Britain, is a problem geologists have yet to solve.

The table D, on p. ix., is too important to be passed over; it is, as the author terms it, a "time table" of all the Silurian *Gasteropoda*, showing the number of species in each genus through the four Silurian stages, and if the species in the work may all be relied on, opens up a mode of time and space analysis whereby any known area, having one or all the stages, may be "censused." That this early epoch in the Earth's history should have contained so great an assemblage of Gasteropodous mollusca, indicating maturity in time and a fitness of conditions for organic life—may seem remarkable—but it will appear ever more so if we examine into the life-history of the *Cephalopoda*, which, during the same epoch, numbered some 1400 species!

Trilobita.—This is the second group selected and treated of by the author, and necessarily so, for they are the medals and type of life peculiar to the seas of Silurian time, and are almost universally spread over the globe. We find 119 genera and 1680 species occupying the rocks of no less than forty-four countries; 74 genera and 1000 species are primordial, and 46 of these 74 [so called] primordial genera are not known above this stage, no one (so far as we know) of the 235 early species, recurring in the overlying Caradoc of any country, or in the Trenton beds of America—and, according to the Thesaurus, we arrive at the fact that "a primordial form has usually a considerable vertical range within its native stage, and there only;"[1] and Barrande and Bigsby, through the labours of Hall and Billings, and the American Palæontologists, determine from materials now collected together in the Thesaurus, "That life began earlier, and more abundantly in the valley of the St. Lawrence and Mississippi than in Europe." This we may qualify, however, through negative evidence, from want of more complete knowledge of the extent and nature of the rocks once occupying the area west of St. David's Head and the south of Ireland, and, indeed, the whole bed of the Atlantic, and, perhaps, also the Bay of Biscay,—for daily we are adding new facts connected with the older and underlying rocks below the "Lower Lingula flags" of the South Wales Promontory; and what do we yet know of the Western promontories of Ross and Sutherland and the Hebrides, or those rock-masses termed the fundamental Gneiss of Murchison. Could we but restore or examine these sub-atlantic deposits in South Wales and North-west Scotland, the St. Lawrence basin and Britain would, probably, be one in *age* and life, one in time and condition. Research tells us that the primordial *Trilobites* alone, in the western valleys of America, number some 40 genera and 200 species, and these assembled in two similar foci or centres, Wisconsin and Lower Canada. Sweden has its own primordial fauna, represented by 18 genera and 56 species; Bohemia, 8 genera and 28 species; Great Britain and Ireland, 11 genera and 33 species.

The author of the "Thesaurus" determines that out of the 57 American genera, 16 are exclusively localised in that hemisphere, and of the 116 European genera, 69 are not known elsewhere; the work also shows that 31 genera have each only one species, and that only one genus of the 31 occurs out of its native area,—*Polyeres* (Bohemia and France); and the largest Genera have been subjected to the widest dispersion, thus—

Calymene,	with	61	species, is known in	29	regions.
Lichas,		82	,, ,,	24	,,
Phacops,		96	,, ,,	26	,,
Dalmannia,		54	,, ,,	21	,,
Cheirurus,		86	,, ,,	26	,,
Illænus,		100	,, ,,	28	,,
Isotelus,		7	,, ,,	14	,,
Proetus,		66	,, ,,	18	,,

We know also that the same species in large genera inhabited many regions widely separated, thus proving their dispersion and distribution over great areas. The British *Calymene Blumenbachii* and *C. senaria*, inhabited 17 regions, from the Trenton Limestone of America to the Wenlock of Wales, Russia, Sweden, Norway, Esthonia, England, Ireland and Scotland. *Encrinurus punctatus* 8, and in two quarters of the globe. *Bumastus* (*Illænus*) *Barriensis* in 10, and all in the Upper Silurian deposits from Sardinia to England, and the American continent. In the year 1858, 126 species of Trilobites were known to Great Britain and Ireland, but in the new (4th) edition of Sir Roderick Murchison's "Siluria," is catalogued 224 species, or one hundred additional forms have been added to the Silurian fauna in 10 years.

At page 71 of the "Thesaurus," Barrande has enumerated for Dr. Bigsby no less than 79 species of Trilobites discovered in the Bohemian basin since 1852

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[1] We do not here discuss the breaks in time either physically or palæontologically; it is too large a subject.

The same author has also constructed another table exhibiting the vertical range and distribution of the Bohemian Trilobites, classified according to the several stages adopted in his own great works upon the Geology and Palæontology of that area; no less than 183 species are thus appointed in time—their distribution in space is chronicled also in the Thesaurus itself, on pages 72*, 72†, 72‡, the particulars of every known genus is tabulated, and through it we arrive at the fact that the Silurian rocks of the world contain 126 well-determined genera, and 1640 species; their distribution is given, and summed up for both hemispheres—48 pages of the table is devoted to this order alone. Well may this have been called the "Age of *Trilobites*" by the older authors, for no epoch of the world's history was ever so characteristically typified by a group so peculiar.

Coeval and cotemporary with, if not preceding in time, the *Trilobita*, stand the *Brachiopoda*. Every ancient sea of the globe seems to have been largely tenanted by this class of mollusca, the group comprises few genera, but is rich in species, no less than 1635 occurring in 47 genera. The most complete analysis as to their distribution and geographical summary is given of this class from page 89 to 126 of the Thesaurus. This order has received more attention from British and Foreign naturalists than any of the mollusca, and no group of fossils have been so well determined. The labours and researches of our own distinguished countryman, Thomas Davidson, F.R.S., into this group of mollusca, have, however, surpassed all other authors. From the Cambrian rocks, through deposits of every age to those still forming in modern seas, this order has lived on, though now but feebly represented [only 11 genera living], 37 having died out. The analytical research of Dr. Bigsby shows us that in the Silurian rocks of the American Continent no less than 1120 species are known, and in the Eastern hemisphere, 1672. Of the 47 known genera, 27 are common to the two divisions of the Globe, 14,[1] are exclusively American, and 14 European.

The *Orthidæ* lived in and were distributed through and over no less than 40 Silurian areas throughout the Globe, 300 species of this family being distributed through the Lower Silurian beds, and 200 in the Upper.

Other large genera as—*Lingula*	occur in	29	countries	or areas.
Atrypa	,,	28	,,	,,
Rhynchonella	,,	31	,,	,,
Spirifera	,,	30	,,	,,
Pentamerus	,,	30	,,	,,

and by way of showing the wide discrepancy amongst the group (or possibly our want of still more perfect knowledge of their distribution than we at present possess) we may instance such genera as the following, which occur only in few areas:—

Camarium in	1	country or area.
Aulonotreta	2	,,
Eatonia	4	,,
Eichwaldia	2	,,
Meganteris	1	,,
Mimulus	1	,,
Pholidops	1	,,
Skenidium	1	,,

The Primordial genera *Lingulella* and *Lingulepis* do not pass to higher stages.

After carefully working our way through the pages devoted to the history of this Lower Palæozoic group of Mollusca in "time and space," we are the better able to appreciate highly the labour which the author has gone through, and which has placed before the student, with but few errors, the labours of our ablest Palæozoic Palæontologists; prominently among whom must stand the names of Davidson, Von Buch, De Verneuil, Hall, and Billings—whose results are now for the first time brought together and classified. No group so conclusively forces upon us the importance of those considerations which we have already dwelt upon relative to first appearance, duration, migration, and extinction through time.

Up to the close of the Cretaceous period, this order formed a conspicuous part of the marine fauna of every epoch, and one or two genera are still largely represented in the seas of Australia, etc.

[1] *Camarium*, *Eatonia*, Eichwaldia, *Lingulepis*, *Pholidops*, *Rhynchospira*, *Tropidolepsus*, *Zygospira*, *Meganteris*, *Skenidium*, *Strophodonta*, *Trimerella*, *Rennselaria*, *Trematospira*.

Echinodermata.—The earliest seas give us also, wherever they are now traceable, countless forms of this class. In the order *Crinoidea*, 78 genera and 315 species are recorded from the many regions where the Silurian rocks containing this group are known; the *Cystideans*, 33 and 136 species; the *Asteridea*, 14 and 90 species, in all 512. Deep interest must always be attached to the distribution and development of this class. The Lower and Upper Silurian stages over the entire world possess a rich assemblage of genera, perhaps the Niagara group of America, the Wenlock Rocks of West Europe, and especially England and Wales, contain the most remarkable forms of *Crinoidea* known. They are brought together and catalogued in such a manner in the Thesaurus, that we can readily mentally restore the old Silurian submarine Crinoidal forests, and whatever may have been the nature of the water or sediment in which they flourished, we are led to examine and weigh with much interest the results embodied in Table K [Geographical Summary] compiled from the 11 pages of the Great Table. The comparatively limited geographical range of some genera, and the colonisation of different areas (widely separated) by the same genera, are problems of high interest to the physicist and naturalist,[1] and the distribution of modern genera in the Caribbean area, Australia, the West Indies, etc., may throw some light upon these remarkable forms of ancient life. America seems to have had two chief foci of concentration widely separated, one in the west, over an extensive old marine area, resulting in the rocks of Illinois, Wisconsin, and Tennessee; the other to the east, in Canada West, and the Northern part of the State of New York.[2] 17 American Silurian areas are enumerated in the table, showing the wealth or poverty of each, *dependent perhaps upon* diligent research on the one hand, or condition of sea, etc., non-favourable to life, and development on the other; such, however, is the state of our knowledge at the present time as to the distribution of this order in North America. Three chief areas in the Western Hemisphere abound in the *Crinoidea* and *Cystidea*, (the British Islands, Russia, and Sweden), and chiefly in the limestone of the Upper Silurian stages,—the Wenlock Rocks of England and Wales, and the so-called Coralline Limestone of Russia yielding the richest harvest. The unequal distribution of the whole class is singularly detailed in the Thesaurus, which clearly suggests the want of research in given regions. Thus:

Only one form (*Edrioaster*) is known in Nova Scotia.
,, Crinoid (*Mariacrinus*) is known in India.
,, *Scyphocrinus* ,, Sardinia.
,, *Hypanthocrinus* ,, Scotland.
,, *Crotalocrinus* ,, Arctic America.

In Spain we only know of two forms, both Cystideans; in Norway, only nine Crinoids and one Cystidean; and in the classical Silurian district, Bohemia, one Crinoid only—*Asocrinus*, and 12 Cystideans; these facts may be termed curiosities of distribution, and will remain so until we know more of the areas and their faunas, through future research.

Cephalopoda.—The names, range, and distribution through the Silurian rocks of 34 genera, and 1419 species, of the *Tetrabranchiate,—Odontophora* close the Thesaurus. It is rendered still more valuable through the liberality of M. Barrande, who placed his MS. list of this great group at the disposal of the author; thus some 500 species are here notified and stratigraphically placed in the Bohemian Rocks, prior to the completion of Barrande's own work upon the *Cephalopoda* of the Bohemian Basin. It is impossible to omit notice of these gigantic Lower Palæozoic pelagic Orthoceratites, whose remains swarm in both the Upper and Lower Silurian deposits of every known region of the globe. 37 areas are enumerated in the Geographical Summary at p. 191 in the Thesaurus, 18 in America, and 19 in the Western Hemisphere; two genera contain collectively 1021 species—viz., *Cyrtoceras*, 317, and *Orthoceras*, 704; the former distributed through 22 countries, the latter 36. Assuming, which we do not doubt, the transcribed correctness and compilation of the author, *the summary of this group is exhaustive;* 22 pages are occupied by the genera and species which are spread through every Silurian deposit known, their universality in deposit and area, and widely spread distribution, demonstrates and testifies to the immensity of time required for the deposition of this older Palæozoic group of rocks, and the life history of the species in this large and highly organised group, which added to that of the *Gasteropoda*, forcibly suggests a still more remote and lost fauna, from which these descended, reaching far back to Laurentian, and pre-Silurian ages. The genus *Nautilus* now represented *by one* species[1] (in the Silurian seas by 21) is the only form that has survived through the stream of time, and each succeeding life-period has seen their decrease in number. Space only forbids us entering into further analysis of this important class of mollusca.

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[1] See the works of Hall, Haydan, Meek, Billings, Schümard, Worthen, De Koninck.

[2] 21 Genera are common to the Western and Eastern hemispheres; 35 are peculiar to America; and 23 are European.

That numerous errors during the progress of the compilation of the Thesaurus should creep in, and occur, is to be expected, and under certain groups *many occur;* these are chiefly in the synonomy of the *Graptolitidæ (Hydrozoa)*—some 30 species are thus duplicated, arising from the author's misconception of the species placed under several genera by different writers upon this group—especially Hall, Geinitz, and others—scattered through many memoirs. A proper analysis of the large genus *Graptolithus* as used by Hall, with those adopted by every other author, would have prevented this. Again, many genera of the *Phyllopoda*, *Ostracoda*, and *Branchiopoda*, as now recognized, should have received more careful analysis relative to their synonomy, etc.; the same species occurring, as in the *Polyzoa*, under different genera.[2] These errors give a plus or minus value to the species, and also to the groups, and, where tabulated, are perpetuated in the same ratio, and right or true deductions upon migration, recurrence, locality, and the longevity and extinction of species can only be drawn from correct identification; these errors in the table, however, are readily corrected by those possessing sufficient knowledge, and need not be perpetuated in succeeding analyses, and the author himself may (if not in another edition) do so in some other form.

We trust that every scientific library, either private or public, will make a point to possess a copy of this great muster-roll of every species known in the Silurian rocks of the globe.

R. E.

II.—RELIQUIÆ AQUITANICÆ; Being Contributions to the Archæology and Palæontology of Perigord and the adjoining Provinces of Southern France. By EDOUARD LARTET and HENRY CHRISTY. Edited by Prof. T. RUPERT JONES, F.G.S. Parts VI. and VII. August and September, 1868.

OUR last Notice of this work appeared in the GEOLOGICAL MAGAZINE for June, 1868, Volume V., p. 282. Part VI. concludes the observations and comparisons between the implements, etc., from the Caves of Perigord, and the implements used among the Laps and North American Indians. On this subject the letter of Mr. Robert Brown (who has only lately returned from a protracted residence in Western North America) will be read with great interest.

This is followed by "An Account of the Human Bones found in the Cave of Cro-Magnon in Dordogne, by Dr. Pruner-Bey," illustrated by six chromo-lithographic plates. Five of the plates are devoted to the crania, and one to limb-bones. The description of these remains extends into Part VII. At p. 71, Dr. Pruner-Bey writes:—"The presence at all levels of the same kind of flint-scrapers, as finely chipped as those of the Gorge d'Enfer, and of the same animals as in that classic station, evidently shows them to be relics of the successive habitation of the Cro-Magnon shelter by the same race of nomadic hunters, who at first could use it merely as a rendezvous, where they came to share the spoils of the chase taken in the neighbourhood; but coming again they made a more permanent occupation, until their accumulated refuse and the debris gradually raised the floor of the cave, leaving the inconvenient height of only 1·20 mètre (about 4ft.) between it and the roof; and then they abandoned it by degrees, returning once more at last to conceal their dead there. No longer accessible, except perhaps to the foxes above noticed, this shelter and its strange sepulture were slowly and completely hidden from sight by atmospheric degradation bringing down the earthy covering, which, by its thickness alone, proves the great antiquity of the burial in the cave.

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[1] *Nautilus pompilius*, the only *Tetrabranchiate Cephalopod* living; in the Silurian deposits there are 1420 known species.

[2] The same may be said with reference to many names given in the addenda, some of which it will be seen are repeated in the general text.

"The presence of the remains of an enormous Bear, of the Mammoth, of the great Cave-Lion, of the Reindeer, the Spermophile, etc., in the hearth-beds, strengthens in every way this estimation of their antiquity; and this can be rendered more rigorously still if we base our argument on the predominance of the Horse here in comparison with the Reindeer, on the form of the worked flints, and of the bone arrow and dart-heads, and on the above-mentioned indications of hunting, as well as on the absence of any engraving or carving. Hence we may refer this station of Cro-Magnon to the age immediately preceding that artistic period which saw in this country the first attempts of the engraver and the sculptor."

He writes, at p. 70, "Amidst the human remains lay a multitude of marine shells (about 300), each pierced with a hole, and nearly all belonging to the species *Littorina litorea*, so common on our Atlantic coasts. Some other species, such as *Purpura lapillus*, *Turritella communis*, etc. occur, but in small numbers. These also are perforated, and like the others, have been used for necklaces, bracelets, or other ornamental attire." etc., etc. Amulets of ivory were also found.

The perforated shells, bone implements, flint flakes, etc., form the subject of the six excellent plates accompanying Part VII.

III—ON SOME PHENOMENA OF THE WEATHERING OF ROCKS, ILLUSTRATING THE NATURE AND EXTENT OF SUBAËRIAL DENUDATION.

By D. T. ANSTED, M.A., F.R.S., &c.

[From the Transactions of the Cambridge Philosophical Society. Vol. xi. Part II. 1868]

PROF. ANSTED here brings forward a number of personal observations on the influence of rain, frost, extreme heat and dryness, and of vegetation acting with the atmosphere in certain cases, in modifying the earth's surface.

Fissures produced in rocks, during long continued dry weather, are more extensive and influential than is generally supposed. Valleys "two or three hundred feet in depth, miles in length, and several hundred yards wide," have originated in cracks, and been gradually enlarged by rain.

The faces of tracts of country are very much changed from time to time by fissures and the agency of rain and frosts, the position as well as magnitude of these openings being changed, whether by the falling in of their sides, the gradual deposit of new material from water running over the surface, or by their being enlarged to form regular valleys. So rapid do these changes take place, that vegetation cannot well exist; there are no trees—hardly even bushes—there is not time for them to grow. In some districts (Algeria, Ionian Isles, &c.) "an air of wild desolation characterises the landscape,"—vast naked expanses of loose soil may be travelled over. Vegetation is in a certain sense conservative, as when the ground is overgrown, the denuding effect of the weather is reduced. In his observations on the Channel Islands, Prof. Ansted mentions that the breaking up of the rocks which form the vast and constantly shifting heaps of sienite is due to rain and frost, assisted by vegetation,—the removal alone is effected by the sea, and that imperfectly.

In some parts of these Islands the Greenstone Rocks are decomposed, and form a sand and gravel, with apparent boulders of the rock itself.

Prof. Ansted gives numerous other notes on the disintegration of rocks, and concludes with a few remarks on the importance of Physical Geography as a key wherewith to unlock some of the mysteries of Geology.

Geologists are at the present time so much at variance as to the amount of credit due to Subaërial denudation on the one hand, and to Submarine on the other, that careful observations on the denudations going on at the present time are of the utmost value. So vast is the amount of sediment brought down by rivers, and to such great distances is it carried away by currents and deposited over the bed of the ocean (as Lyell shows in the last edition of his "Principles," vol. i.), that perhaps, when looking at the immense thickness of sedimentary deposits containing marine shells, we are apt to attribute too much to the sea, when a very considerable part of the sediment might have been brought down by rivers, the result of Subaërial Denudation.

REPORTS AND PROCEEDINGS.

Geological Society of London.—Nov. 25th, 1868.—1. "On Floods in the Island of Bequia." By G. M. Browne, Esq. Communicated by the Secretary of State for Foreign Affairs.

On the 17th of March, at 8 o'clock p.m., a steady strong wave was seen bearing down upon Admiralty Bay; it had no perceptible crest, and was three feet in height; it encroached upon the land to distances varying from 70 to 350 feet. A second smaller wave followed. No shock of an earthquake was felt.

Discussion.—Dr. Duncan wished for some explanation of these earthquake waves, more especially with regard to the effects of supposed cataclysmic waves. He considered that they arose from sudden changes in the level of shoals or littoral tracts, and not from deep-sea disturbances.

Mr. Babbage suggested that, assuming an eruption of lava at the bottom of the ocean, there might be such an amount of steam generated, or even such a decomposition of water, as would originate waves of enormous volume.

Sir C. Lyell was inclined to the same opinion, and not to limit the causes of these waves to oscillations of the surface of the earth.

2. "Description of Nga Tutura, an Extinct Volcano in New Zealand." By Capt. F. W. Hutton, F.G.S.

This volcano is situated on the west coast of the North Island of New Zealand, between Raglan and the mouth of the River Waikato.

A section of 15 miles is exposed along the coast, which trends in a north-west and south-east direction, showing beds of Mesozoic age forming a synclinal trough between the south head of Waikato and Otehe Point, and descending below the sea-level at Waikawau. Upon them lie Tertiary strata, following the same synclinal curve as the older rocks, and broken through, nearly in the centre of the curve, by the basaltic cone of Nga Tutura. This volcano is about 600 feet high, and is chiefly composed of basaltic lava-streams, with but little tuff. The eruption is considered by the author to have been submarine.

Captain Hutton then stated his conviction that the fluid matter which escaped was not connected with a central molten interior of the earth, but was derived from rocks not much more than 1000 feet in depth, and that the synclinal in question was caused by a subsidence into the cavity thus formed.

Discussion.—Prof. T. Rupert Jones would be glad to hear Dr. Hector's opinion on the subject before Mr. Heaphy's views were entirely condemned.

Mr. David Forbes could not see that the author had brought any conclusive proof that the lava was derived from so inconsiderable a depth. From his examination of the lavas of Polynesia, of Europe, and of other localities, he was satisfied that their chemical constitution was the same, and therefore that their products were derived, not from any merely local sources, but from some more or less connected extensive internal reservoir. In answer to Sir C. Lyell, he showed, from the eruption of Santorin, that the trachytic and basaltic lavas came from the same source, inasmuch as they issued from one and the same crater.

Mr. W. W. Smyth was gratified that one of the results of the new system of education of military officers was productive of such good results in a geological point of view.

3. "On *Dakosaurus*." By J. Wood Mason, Esq., F.G.S. The Kimmeridge Clay of Shotover Hill has yielded five specimens of the teeth of this reptile, now for the first time represented as a British genus. After noticing the bibliography of the subject, and the presence of specimens in various museums, the author proceeded to describe the characters of the teeth. They are large, conical, incurved, and slightly recurved, having two sharp, prominent, crenulated, longitudinal ridges, which are situated midway between the convex and concave curvatures.

This reptile was regarded by the author as foreshadowing the form of dentition that characterizes the existing group of *Varanidæ.* If the materials were at hand for a complete definition of its comparative osteology, *Dakosaurus* would probably exhibit a combination of Lacertilian and Crocodilian characters, but with the crocodilian elements predominant.

Discussion.—The President differed from the author as to the conclusions he drew from the structure of the teeth. The teeth of existing Crocodilia had been but imperfectly described, and he thought he could point out among existing Crocodiles, teeth bearing the character which the author regarded as Lacertilian. He agreed with Professor Owen in regarding *Dakosaurus* as Crocodilian rather than Dinosaurian or Lacertilian.

Mr. Wood Mason had seen in the Gavial of the Ganges, and in the teeth of Teleosaurians from the neighbourhood of Oxford, the same crenulations and compression which he regarded as indicative of a Lacertilian character.

4. "On the Anatomy of the test of *Amphidetus* (*Echinocardium*) *Virginianus,* Forbes; and on the genus *Breynia.*" By P. Martin Duncan, M.B., F.R.S., Sec.G.S., etc.

After a careful examination of the Miocene *Amphidetus* from the Virginian Tertiaries, the recent species of the genus from the European and Australian seas were stated to form a group of very closely allied forms. The Crag specimen of *A. cordatus* described by Forbes could not be found; but the examination of a series of recent specimens decided that they were not specifically different from the Miocene form.

The unusual form of the ambulacral spaces, the nature of the fasciole crossing them, and the resulting absence (more or less) of pores within the fasciole, were asserted to be of a third-rate character as regards structural importance; and the author did not consider that the genera *Echinocardium, Breynia, Lovenia,* etc., had a common origin, or that there was a close generic relationship between them, because they had this fasciolar structure. He considered the fasciole to be an appendage to several generic groups which were distinctly separated by other structural distinctions. The result of an examination of the Nummulitic *Breyniæ* in the Society's collection satisfied Dr. Duncan that there were only race characters separating them from *Breynia Australiensis*—a recent Echinoderm. The persistence of these species, widely distributed and of great geological age, was very remarkable.

Discussion.—The President regretted, with the author, the prevailing custom of determining species as much by their geological position as by their structural affinities. He thought it was necessary to have a knowledge of living forms, in order to estimate correctly the value of the characters of extinct species. He considered that the presence of similar fascioles in different genera might be explained in the opposite way to that which the author adopted, and that they might be considered evidence of genetic connexion, subsequent variations having produced differences of generic value.

Mr. Gwyn Jeffreys also considered that every palæontologist ought to be a naturalist, as the fossil and recent forms are intimately connected by insensible gradations. All the *Echinocardia* with which he was acquainted were inhabitants of clean sand.

Dr. Duncan, in reply, stated that if the Spatangidæ were classified, generic distinctions would be observed quite irrespective of the presence of fascioles. He considered the fascioles, like the horns of Mammalia, of third-rate structural importance. One specimen from Arabia appeared to have a fasciole developing. He remarked that all the fossils were of the same size, so that it was impossible to determine whether the formation of fascioles was dependent on embryonic conditions, or whether they were developed in the perfect animal.

II. December 9th, 1868.—1. "Notes of a Geological Reconnaissance in Arabia Petræa." By H. Bauerman, Esq., F.G.S.

The district to which this paper referred is that between Suez and the lower part of Wady Ferran, in the Peninsula of Arabia Petræa, and includes the copper and turquoise mines worked by the ancient Egyptians. The rocks within this area were classified as follows:

1. Gneiss and granites, forming the central chain of Sinai and the base of all the stratified deposits.
2. Red Sandstone series.
3. Cretaceous rocks.
4. White limestones, with flints, salt, and bitumen. Eocene.
5. Flint conglomerate, with coralline limestone. Miocene.
6. Gypseous marls of Wady Taragi.
7. Reconstructed gypseous sands and conglomerates.
8. Raised beeches, coralline and miliolitic limestones.
9. Alluvium and desert drift.

The Red Sandstone series consists of three members, a thin bed of limestone being the central, and containing remains of encrinites, referred by Mr. Etheridge to the Muschelkalk form *Encrinites moniliformis.* Iron, manganese, and copper ores are found near Nasb and Serabib el Khadem. The turquoise mines of Wady Maghara, which were referred to the same horizon, are among the most ancient monuments of the world. The author considered that the tools employed were flint chisels or flakes, and hammers made from pieces of a neighbouring doleritic lava. The flakes were supposed to have been mounted on wooden blocks.

The Cretaceous rocks which rest unconformably on the Triassic sandstones, consist chiefly of green sand, with alternations of thin argillaceous limestones, containing Echinoderms, which prove them to be of the age of the Upper Greensand. Above them comes the Hippurite-limestone series. The fossils were described by Dr. Duncan, F.R.S., in a subsequent communication.

The white limestone, with flints, the next group of rocks in ascending order, strongly resembles the European Chalk with flints; but, according to the author, it must be regarded as representing the Nummulitic limestone of Egypt, as several species of Nummulites have been detected in it near the shores of the Red Sea, below Wady Gharandel. The Miocene flint conglomerate series is a mass of coarse flint shingle alternating with these Coralline limestones. The author considered that a great physical break ensued between the Eocene and Miocene period, while a gradual transition occurred between the Cretaceous and Eocene rocks.

In the Gypseous series which overlies the flint conglomerate several peculiar effects were noted, owing to the easy manner in which tumbled and broken masses of gypsum are reconstructed by partial solution and recrystallization when they have been removed from their original position by the slipping of the underlying shales.

The alluvial gravels of the Sinaitic valleys are generally similar in containing a coarser and a finer material; the latter is the older, and has apparently been deposited by comparatively slowly-flowing streams. In conclusion, the author called attention to the evidence of lakes, marshes, and streams having formerly occupied what are now dry barren valleys.

Discussion.—Mr. Gwyn Jeffreys corroborated the opinion of the author, that there had been at one time permanent marshy lands where the *Lymnæa truncatula* and a species of *Pisidium* had been found.

Mr. D. Forbes inquired the age of the schists and porphyries of Om Riglaine, and as to the character of the granite.

Sir R. I. Murchison inquired the probable age of the masses of gypseous rocks, and commented on the extremely wide range of the Nummulitic strata.

Dr. Duncan observed that the Cretaceous fossils, as had been observed by both M. Louis Lartet and himself, belonged to the Upper Greensand formation. He considered that the author had proved that the Red Sandstone was not, as suggested by M. L. Lartet, Neocomian, but either Triassic or Permian. Fossils of the Upper Chalk with flints he found to be absent. He had found that, out of 25 Cretaceous species, 13 had been described by M. Coquand from Kabylia and Egypt, while 8 were European forms.

Mr. Etheridge considered the fossils from the sandstone to belong to the Trias, especially from the presence of *Encrinus moniliformis*.

Prof. T. Rupert Jones reported the Nummulites as of the common typical form found in Egypt—the *N. Ghizensis*. With a variety of this form occur some others. If the Nummulitic rocks were overlain by the soft white friable limestone, this latter, like similar beds in Scinde, would be of later date, though similar in lithological character.

Mr. W. W. Smyth had found in Nubia, above the Catacombs, Red Sandstones overlain by limestone and Nummulitic beds. If the Red Sandstone, as seems probable from the fossils discovered by Mr. Bauerman, were proved to be Triassic, a great point in the geology of Sinai and the East had been gained.

Mr. Boyd Dawkins inquired as to the evidence of the mines having been worked by the Egyptians.

Mr. Evans was not satisfied that the flint flakes had been used in the manner suggested, as they would be liable to break off in the socket, and the hammers would not be worn away in the manner they exhibited by mere impact on wood.

The President commented on the similarity of the faunas of India and South Africa, and hoped that Mr. Bauerman's future researches might throw light on the ancient connexion of these continents.

Mr. Bauerman stated in reply that he did not regard the white limestone as true Chalk. He considered that the slabs showed conclusive evidence of having been chiselled by means of the flints.

2. "On the occurrence of Celestine in the Tertiary rocks of Egypt." By H. Bauerman, Esq., F.G.S., and C. Le Neve Foster, D.Sc., F.G.S.

This communication referred to the presence of celestine at two different horizons in the Tertiary escarpment of Mokattam. The beds forming the escarpment may be divided into two parts, namely, the upper beds, which are brown, sandy, cellular limestones with numerous oyster-beds, and the lower, or white Nummulitic limestone proper. A bed of marl with fibrous gypsum generally occurs at the junction of the two groups of strata.

In the upper or brown beds celestine occurs with gypsum, sometimes in isolated crystals, but more generally in stellar or spheroidal nodular aggregates, the points of the crystals being turned outwards. About thirty feet lower down in the white limestone, rough irregular crystals of the same mineral are found in open hollows or druses. They are often large, but much decomposed, and apparently crusted with Nummulites, Bryozoa, &c., which are in reality included in the crystals, and have become exposed by erosion. The erosion and alteration of the crystals commences by the roughening of the faces of the prism, owing to the formation of numerous fine striations parallel to the basal planes, and goes on frequently until the crystals have entirely disappeared. The ultimate product is a hollow cast of the crystal, which may then be filled with limestone, forming a pseudomorph by a total replacement. This, however, appears to be rare. More generally the dissolved celestine has been redeposited upon the altered crystals, forming macled groups. The secondary crystals are compact, brilliant, and well formed, without included foreign bodies. These phenomena were attributed by the authors to the solubility of sulphate of strontia in chloride of sodium.

3. "Note on the Echinodermata, bivalve Mollusca, and some other Fossils from the Cretaceous Rocks of Sinai." By Dr. P. Martin Duncan, F.R.S., Sec. G.S., &c.

The author identified the fossils brought by Mr. Bauerman from Sinai as belonging to the Upper Greensand and Hippuritic Chalk horizons, and correlated them with those of Algeria and South-eastern Arabia. He determined the following species:—

Heterodiadema Libycum, Ag. & Desor, sp.
Discoidea subucula, Klein.
—— *Forguemolli*, H. Coq.
Epiaster distinctus, Agass.
—— *tumidus*, Desor.
Periaster oblongus, D'Orb.
Hemiaster Cenomanensis, Cotteau.
Phymosoma Delmarrei, Desor.
Pseudodiadema variolare, Brongn.
Pedinopsis, sp.
Plicatula Fourneti, H. Coq.
Pecten asper, Lam.
Neithia alpina, D'Orb.
Neithia tricostata, Boyle.
Exogyra plicata, Goldfuss.
Ostrea Auressensis, H. Coq.
—— ——, *var. major*, nobis.
—— *Mermeti*, H. Coq.
Exogyra Overwegi, von Buch.
Ostrea Delattrei, H. Coq.
—— *curvirostris*, Nilss.
Caprotina Toucasiana, D'Orb.
—— *subæqualis*, D'Orb.
——*Archiacianus*, D'Orb.
Radiolites, sp.
Clavagella, sp.

4. "On the existence during the Quaternary Period of a Glacier of the Second Order, occupying the 'cirque' of the valley of Palhères in the western part of the granitic 'massif' of the Lozère." By M. C. Martins, For. Corr. G.S.

After mentioning that no one had satisfactorily proved the former existence of glaciers in the Puys of Auvergne, the Cevennes mountains, or the massif of the Lozère, the author stated that, from studying the Government map, it occurred to him that traces of a glacier ought to be found in the eastern part of the granitic massif of the Lozère, at the upper portion of the Valley of Palhères, which opens near Villefort. An examination of the district in question proved the former existence of a glacier which was limited to the cirque which enclosed it, and did not descend into the valley. A lateral and a terminal moraine were found, and *roches perchées* were observed on the sides of the valley. No striæ or polished surfaces were seen, owing to the schistose rocks being easily decomposed.

EDINBURGH GEOLOGICAL SOCIETY.—THE PRESIDENT'S ADDRESS. —On the 3rd December, 1868, the newly-elected President, Archibald Geikie, Esq., F.R.S., etc., Director of the Geological Survey of Scotland, delivered the following address.

Mr. Geikie, after thanking the society for the compliment which they had paid him in electing him their President, passed on to notice some of the functions of scientific societies. These, he said, may be conveniently divided into two classes—first, those of a national character, like the Royal Society, the Geological Society, and the Chemical Society of London; and second, local societies, properly so-called. The functions of a local society are five-fold—first, to exhaust, so far as possible, the geology, botany, or natural history, as the case may be, of its own district, and to methodise and encourage the observations of an organised body of workers among its members; secondly, to watch every change within the scope of its own science which may arise in the course of human progress—for example, in botany, to note the changes caused by man's interference upon the plants of a district; in geology, to notice the effects revealed by every new quarry, railway cutting, or exposure, along with the influence of man upon existing geological processes; third, to bring forward at evening meetings notices of all new observations made by the members or by others in the district, and to preserve, and where possible, publish a record of these observations; fourth, to aid the researches of men who are devoting themselves to any special branch of science, by furnishing them with carefully verified facts and specimens, or other material which may be required; and fifth, to foster among its own members and in the outer world a love of the science which the Society is specially formed to cultivate. In regard to the Edinburgh Geological Society, the author pointed out how advantageously situated it is for the study of geological science. No better field for the prosecution of that study can be found than the neighbourhood of Edinburgh, while the libraries and geological collections in the city afford excellent help to the student.

And notwithstanding the extent of the literature devoted to the geology of Edinburgh, much remains still to do; and much may be entered upon by the members of such a Society as the Edinburgh Geological Society. In the first place, there is the palæontological domain. The Silurian Rocks of the Lammermoors and the Moorfoot Hills have no doubt still some fossil treasures to show. The Upper Silurian Rocks of the Pentland Hills have been carefully searched by several members of the Society, who have amassed a large collection of the organic remains of that locality; and it woudl be well if the other geological formations of the district were as thoroughly explored. The Old Red Sandstone of the Pentland Hills has not as yet yielded any fossils, but hopes may be entertained that, especially in the neighbourhood of West Linton, some *Cephalaspidæ* and Crustaceans of the lower beds of that formation may yet be found. Mr. Geikie is of opinion that in all likelihood there is in reality no true Upper Old Red Sandstone in this district, but that what has hitherto been so esteemed will prove to belong in reality to the lower division of the system. The Carboniferous system of the district furnishes in itself a wide field of research. Each of its broader divisions can be distinguished by fossils, and what the members of the Society might be strongly advised to illustrate is, how far each separate bed contains distinct fossils, also how far the same bed shows a change in its fossil contents as it passes from one district to another—for example, how far the organisms in the Burdiehouse limestone resemble or differ from those on the same horizon in West Lothian and East Lothian. There is also an interesting field of inquiry in connection with former volcanic conditions during various portions of the Carboniferous Period, and Mr. Geikie suggested as a profitable subject of investigation, whether, in the neighbourhood of interbedded volcanic rocks, any change in the contemporaneous flora or fauna could be made out.

In the neighbourhood of Edinburgh no stratified rocks have yet been found between the Carboniferous system and the Boulder-clay. Underneath the Boulder-clay, in certain localities, gravels and sands occur, in which it might be of great advantage to institute a careful and continued search for organic remains, such as might serve to indicate the nature of the plants and animals living in this neighbourhood at the commencement of the Boulder-clay period. The Boulder-clay itself, notwithstanding all that has been done in recent years, still offers many opportunities of useful inquiry. It is in reality a complex formation, and members of the Society might do much good in trying to trace out its subdivisions. They ought especially to watch every new cutting and exposure of the clay, or of the sand-beds contained in it, with the view of detecting, if possible, any organic remains, more particularly shells of an Arctic character. They should also wash samples of the clay from each district, with the view of discovering foraminifera, as has been done so successfully in other districts. Nor need they even despair of discovering Mammalian remains, for he need not remind them that within eight miles from where they were assembled the tusk of a

Mammoth had been taken out of the Drift-beds. The sands and gravels that lie upon the Boulder-clay present still many problems, which are more likely to receive solution from the organized observations of a local Society than from the work of single individuals. Later than the Drift come the old river terraces, in which, so far as the neighbourhood of Edinburgh is concerned, no human remains have yet been detected, nor, indeed, any evidence of those conditions which are illustrated by the old river gravels of the south of England and the north-east of France.

Passing next to the petrology of the district, Mr. Geikie pointed out that the neighbourhood of Edinburgh furnishes admirable illustrations of metamorphism in the Lower Silurian Rocks, with many syenites and porphyries. The volcanic rocks of the district have long been famous; nevertheless much has still to be learned regarding their chemical and mineralogical composition. The nomenclature of crystalline rocks is in a most deplorable state in this country. It remains, indeed, in much the same state as it was about the beginning of the century. There is, therefore, no branch of geological inquiry which, at the present time, offers greater prospect of new and important results. Chemistry and mineralogy are both needed. The chemist may tell the ultimate chemical composition of the rocks, but not so well their mineralogical arrangement. That is best done by the help of the microscope,—an instrument which will undoubtedly come to be an indispensable part of the equipment of every field geologist. In conclusion, he showed that the preparation of elaborate papers is not necessary; that the Society ought not to be too ambitious; that though elaborate papers of great merit will always be heartily welcomed, it can hardly be hoped that such papers will be numerous. The members, however, will do good, not only to themselves, but to the cause of the science which they cultivate, by bringing to their meetings notices of new facts and discoveries made either by themselves or by others. These notices the Society ought to preserve, and, if possible, from time to time publish. Many people speak disparagingly of such local efforts, but, in truth, science would often make but slow progress without them. A local Society will do far more good to geology by carefully illustrating the geological structure of its own district, than by attempting to furnish such papers on the science as, in justice alike to the author and the cause of science, can only properly be done by a great national society like the Geological Society of London. Its ambition should be to be distinguished by the amount of useful work which it can do, being well assured that no such work, no matter how local in its first aspect, can be honestly done without adding something to the stock of knowledge, and thereby advancing the cause of science.

Geological Society of Glasgow.—I.—Nov. 5th, 1868. Professor John Young, M.D., etc., President, in the chair.

Mr. James Armstrong exhibited a well-preserved fin-spine of *Orocanthus*, from the Carboniferous Limestone at Roughwood Quarry, near Beith. This massive spine—new a sa Scottish fossil—is characterized by its large size and pyramidal shape, and by its interior being quite hollow, except at the apex; whereas in the other genera of fossil Plagiostomes the spines are narrow, gradually tapering, solid, and in many cases furnished with one or more rows of denticles. *Oracanthus* is further distinguished by the blunt tubercles which, either singly or in ridges, cover its surface.

The President also exhibited a new icthyodorulite, sent by Mr. Robert Craig (a Corresponding member), from Langside Quarry, near Beith.

Mr. John D. Campbell exhibited some specimens of wood encrusted with oxide of iron from the head of Loch Melfort, Argyllshire. In the same section fragments of wood and hazel-nuts in a good state of preservation were found, showing that the incrustation of the specimens exhibited was due to local oozing of water charged with iron.

The following papers were then read:—

1. "On the section of strata at present being worked in the western portion of the Gilmorehill grounds, for the purpose of obtaining Building Stone, for the erection of the new University." By Mr. John Young.—The paper was illustrated by specimens of the sandstone, etc., and by vertical and horizontal sections of the strata in the quarry. The chief interest to a geologist in this quarry consists in the numerous strata therein exposed, there being no fewer than twenty-six different beds in the depth of sixty feet from the surface. These consist of five seams of free coal, varying in thickness from nine to eighteen inches: five beds of sandstone, with accompanying strata of clay shale, bituminous shale, fireclay, and a thin seam of blackband ironstone. The geological position of the strata is in what is known in the Glasgow district as the Possil Lower Coal and Ironstone series, which lies about 510 fathoms under the Upper Red Sandstone of the Lanarkshire Coalfield. Mr. Young next pointed out the relation which the Possil series bears to the strata of other portions of the Scottish Coalfield, and stated that they occupy a middle position in the Carboniferous Limestone series of this country; yet in this district, throughout a thickness of 900 feet, no limestone band or other calcareous strata are found. Their lithological character, and the nature of the organic remains, present us with conditions very similar to that which prevailed during the deposition of the sedimentary strata of the Upper Coal-measures of Western Scotland.

The sandstone of the Gilmorehill quarry is a whitish fine-grained rock, streaked at intervals with carbonaceous matter. It occurs in beds, the thickest of which is fully 12 feet. The five beds in the quarry will yield about 40 feet in thickness of good serviceable rock.

During the working of the uppermost part of sandstone in the quarry, the workmen came upon the remains of the stumps of five large fossil trees standing in an erect position, with their roots extending into the bed of shale upon which they once grew. They belong to the genus *Sigillaria*, and while they were allowed to remain in position they formed a very interesting object in the quarry.

The Boulder-till occurs at Gilmorehill of great thickness, the valley of the Kelvin having been scooped out of it down to its present bed, it is of the same normal character as that which covers the country around Glasgow. It contains many striated stones belonging to various rock-formations. The direction of the striæ on the surface of the underlying rocks at the quarry shows that the great ice-sheet had passed over this part of the district nearly from west to east, which is the average direction of the glacial striæ in this tract of Scotland.

2 "On the Claystones of Arran." By the Rev. John F. Potts, B.A.—The author of this paper stated that by the familiar term claystone he desired to indicate the whole group of the Arran rocks, of which the base was a felspathic paste. These rocks are beautifully developed in the pretty Ben Leister Glen, at the N.W. corner of Lamlash Bay, where there exist upwards of a dozen large dykes of the several varieties. Singular to say, these claystone dykes are, with one exception, always found in that Glen associated with parallel and contiguous dykes of common basalt or greenstone. The former are, however, invariably many times as thick as the latter, and were evidently injected first into the fissures. The igneous origin of claystone was the point first demonstrated, although attention was called to some extraordinary appearances in the Glen, which taken alone would lead to an opposite inference, such as the existence of pebbles in the heart of the claystone, and the curious fact, already alluded to, of double dykes occurring together with such frequency. But this latter phenomenon was explained on the supposition of two distinct sets of volcanic disturbances. Claystone, being a less crystalline rock, must have been erupted near the place where it is now found. The Holy Isle, Dun Dhu on the Corrygills shore, and the well-known Windmill Hill near Brodick are all huge pyramids of claystone resting upon the same sandstone that is found in the Ben Leister Glen containing the dykes. These three remarkable hills were probably ancient volcanoes, and as they are all equally near the glen in question, the terribly shattered character of its bottom may be explained. A subsequent renewal of volcanic action opened still further the fissures formerly produced there, and these, becoming filled with a more fluid lava, caused the phenomenon of the double-dykes. The author desired it to be understood that he made these suggestions merely with the hope of attracting attention to this very interesting group of the rocks of Arran.

II.—3rd December, 1868. Edward Hull, Esq., F.R.S., Vice-President, in the chair.

The Chairman exhibited a specimen of native copper in trap, and Prehnite embedded in analcime.

Mr. John Young exhibited a fossil fruit nearly allied to *Trigonocarpum*, from the Carboniferous limestone shales of Calderside, High Blantyre, but it differs from that genus in possessing eight ribs near the apex. Also from the same beds, *Griffithides mesotuberculatus*, M'Coy—one lying extended in the shale, and the other coiled up.

The occurrence of this crustacean in a perfect condition is extremely rare.

Mr. James Bennie exhibited a fossil fruit—*Trigonocarpum*—and pieces of carbonised wood from a truly marine shale in Shiels Quarry, East Kilbride. He also exhibited a series of pyritized twigs from the marine shales of Lickprivick, East Kilbride.

The Chairman presented and explained a map of Great Britain which he had prepared at the request of the Royal Coal Commission, to illustrate his views regarding the extent and depth to which the coal-fields of England stretch beneath the Mesozoic formations. The map showed that while there is a large area in Cheshire, Staffordshire, Warwickshire, Leicestershire, Notts, and Yorkshire formed of Triassic and Permian rocks overlying the coal, yet that this mineral does not extend under the eastern and southern counties of England, which are considered to be formed of newer formations resting on rocks of older age than the Coal-measures. The map is to accompany Mr. Hull's evidence when published in the " Blue book."

A communication was read from Mr. Alexander Currie, one of the members, on the recent discovery of ancient canoes near Bowling. Mr. Currie gave an historical *resumé* of the occurrence of ancient canoes in the bed of the Clyde, and in lakes and marshes throughout the other parts of the country. An account was then given of the discovery by the writer of the canoes, which formed the special object of his paper. Two of these he had exhumed from the bed of the river near Dunglass. They were found lying abreast of each other, embedded in tenacious clay, containing water-worn boulders, overlain by a deposit of alluvial mud. The longer of the two consists of a rough undressed tree, 23½ feet in length, and 11 feet in mean girth, the inside being beautifully hollowed out. The lesser canoe measures 13 feet in length, 3 feet in width, and is shaped like the modern fishing cobble, with square stern. The third canoe had been found opposite Dumbuck, by parties in Dumbarton, from whom it had passed into the possession of the writer. Like the last, it is formed out of a dressed oaken log, and measures 23 feet in length and 31 inches in breadth, its depth not being ascertainable owing to its sides being in an imperfect state. The remaining portion of the paper contained his speculation as to the people by whom these relics were fashioned, and the probable time which had elapsed since they became entombed in the river-silt. J. A.

DUDLEY AND MIDLAND GEOLOGICAL SOCIETY.—This Society held the first of the series of winter meetings, in the Museum, on Friday, the 27th November. The chair was taken by H. Beckett, Esq., F.G.S. Mr. Hollier exhibited the Trilobite from the Dudley Limestone, described by Mr. H. Woodward in the GEOLOGICAL MAGAZINE, for November, as *Calymene ceratophthalma,* having all the characteristics of the well-known *Calymene Blumenbachii,* but with eyes placed on the end of long peduncles. This curious specimen gave rise to an animated discussion, in which all the speakers expressed themselves as dissenting from Mr. Woodward's views; but whether the so-called eye-peduncles were really the reversed cheek-margins of the same Trilobite, or belonged to another individual, seemed to admit of some doubt. Several interesting illustrations in confirmation of the latter of these opinions were exhibited. There seems to be no doubt that the fossil in question has been mutilated, as Mr. Johnson stated that when he first saw it the margins of the sessile eyes of the common *Calymene Blumenbachii* were distinctly visible.[1] Among the fossils exhibited may be mentioned one which Mr. Beckett considered as a *Calamite*, from the Dudley Limestone, though the absence of all remains of land-plants in these early measures pointed rather to the specimen exhibited being an *Orthoceras*. Mr. Hollier exhibited a number of beautiful Trilobites and several *Limuli* from the Coal-measures. Mr. Ketley also exhibited a specimen of *Phacops Downingiæ*, var. *spinosus*, only one specimen of which is recorded, and that from the Ludlow rock.—*Dudley Herald*, Dec. 5, 1868.

MONTREAL NATURAL HISTORY SOCIETY.—The usual monthly meeting of this Society was held on Monday evening, Oct. 26th, 1868. The President, Principal Dawson, F.R.S., etc., etc., in the Chair. E. Billings, Esq., F.G.S., read a paper entitled, "Note on the Bones of a Mastodon found near Dunnville, Oct., 1868."

On reading the announcement in the papers of the discovery of the bones of a Mastodon, near Dunnville, two weeks ago, I left Montreal by the first train for the locality. On arriving there, I found that the accounts were somewhat exaggerated. The remains were not so large as had been reported, and besides were in a very poor state of preservation. The tusks had almost entirely disappeared—there remaining only two or three small fragments, about a foot long and one or two inches thick. No part of the head remained except the posterior portion of the right ramus of the lower jaw. There are seven molar teeth with the enamel, as usual, well preserved. There is a nearly perfect thigh bone and several other bones of the legs and feet, most of them more or less broken and decayed. There are a few of the vertebræ, some fragments of the ribs, and a number of other imperfect bones.

On examining the teeth, I found the remains to be those of the common American species *Mastodon Ohioticus* or *Trilophodon Ohioticus*, according to Dr. Falconer's classification. Judging from the size of the teeth and femur, I should say that this animal was a Mastodon of medium size, perhaps nine feet in height. I do not think the tusks could have been fourteen feet long. The longest and most perfect skeleton of this species known is that which was mounted by the late Dr. Warren, of Boston, and which is now, I believe, in one of the museums of that city. It measures seventeen feet in length from the front part of the face to the insertion of the tail, and is a little over eleven feet in height. The tusks are about eleven feet in length, and it seems probable, therefore, that those of the Dunnville skeleton were not so long.

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[1] See Mr. Woodward's letter in Correspondence, page 43.

The remains were found in a swamp, about one and a half mile north of Dunville, partly imbedded in a layer of fine sand, holding fresh water shells of species now living in our rivers, lakes and ponds. The sand is two and a half feet thick, rests upon Boulder-clay, and is overlaid by one and a half feet of black vegetable mould. None of the bones, as I understand, were found in the clay, but they partly projected up out of the sand into the mould. It is clear, therefore, that this animal lived long after the close of the Glacial period.

From Dunville I went to the Niagara Falls, where there are preserved in Mr. Barnett's museum, a nearly perfect lower jaw of a small Mastodon from St. Thomas, Ontario. The molars are all in place, and the specimen is interesting, as it retains the two small tusks that are seen in the lower jaw of the young Mastodon, but not in the adult. Mr. Barnett has a number of other teeth and lower jaws, both of the Mastodon and Mammoth, which he has collected from different places in the western parts of Ontario. There are three molars of the Mastodon in the Provincial museum from London, besides the collection of Mammoth's bones from Hamilton. These are all the fossil elephantine remains that have been collected in Canada to my knowledge.

It is worthy of note that none of these remains were collected east of the western extremity of Lake Ontario. It would seem that when the Mastodon and Mammoth roamed over Canada, the distribution of land and water was somewhat different from what it is now. The great escarpment (usually called the Niagara ridge) which runs from Lewiston to Hamilton and thence to Owen Sound, formed a shore of only a few feet in height, and all west of it was a low flat country abounding in swampy land, where grew the cedar, spruce, and other evergreens, upon whose leaves and twigs the Mastodon appears to have subsisted. Easterly there was a great fresh-water sea that covered a large area of the present dry land of Canada, and of the neighbouring states. No remains of these animals have been found in Canada at any place east of Hamilton; and it is not difficult to show that those collected there had been drifted down from the interior by the river that once flowed through the ravine at Dundas. In the States they have been collected in numerous localities all over the country, to some point as far east as Massachusetts. A line drawn north-easterly from Hamilton to New Brunswick would, according to our present knowledge, form the north-western boundary of the country inhabited by the Mastodon and Mammoth in the Dominion.

Principal Dawson, LL.D., F.R.S., F.G.S., &c., exhibited some specimens of graphite from Buckingham, Q.C., and remarked on the parallelism between its mode of occurrence, whether in beds or veins, with that of the occurrence of bituminous matter, of organic origin, in limestones and shales, and in the veins or fissures traversing such rocks; arguing that if the graphite of the Laurentian rocks is assumed to be of organic origin, these rocks, when originally deposited, must have held vast quantities of vegetable debris, and must have constituted highly bituminous limestones and shales, the volatile matter of which had probably been dissipated and the carbon brought into the state of graphite, before the commencement of the Silurian period. In evidence that such a change might be effected without any great amount of heat, he adduced the fact that in the Devonian rocks of New Brunswick, trunks of trees and even the most delicate leaves of ferns have been converted into graphite without obliterating their structure.

ANTHROPOLOGICAL SOCIETY OF LONDON.—15th December.—DR. James Hunt, President, in the Chair.—Dr. Carter Blake, F.G.S., Hon. Memb. A.S.L., made a communication on the skull, jaw, and limb-characters afforded by the specimens recently discovered at Cro-Magnon (Les Eyzies), France, and contrasted them with those of similar, and in one case greater, age from the Belgian bone-caves. He pointed out that whilst the Belgian caves afforded evidence of man in some degree pithecoïd, yet, on the whole, exaggerating the characters of the lower Sclavonian races; the French remains were entirely *sui generis*, and were those of men who, although presenting some simial characters, yet, in cerebral capacity, were superior to most existing races, and in some respects resembled the Celtic crania of the present day.

CORRESPONDENCE.

GLACIERS IN SOUTH DEVON.

SIR,—As the question whether there are traces of glacial action in Devon is occasionally mooted, I send a few lines relating to that point. My own practical acquaintance with Glaciers is confined to one hurried visit to Switzerland, and on that account I did not venture in my paper "On the Geology of the Valleys of the Upper part of the River Teign and its feeders" (Quarterly Journal, vol. xxiii. p. 418), to ascribe any of the gravels, or transported rocks, to that cause, but named the gravel, deposited before the "re-excavation" of the valley, "old gravels." Since the meeting of the British Association, an eminent continental geologist paid me a visit to examine the granite of Dartmoor, and on passing a place where the "old gravel" is exposed, said, "this is a Moraine; a Swedish or a Swiss geologist would say this is a Moraine." He examined other "old gravel" sections, and gave similar opinions on the spot, which he confirmed on further consideration, and on examining the map of the district; for "old gravels," therefore, the word "moraines" may probably be substituted. I do not feel justified in publishing the name of my friend, as I omitted to ask his permission so to do, but enclose it for your private satisfaction; and I trust that your readers will rely on me when I say that he was a well-known Professor, on whose opinion the most eminent geologists would place the greatest reliance.

G. WAREING ORMEROD.

CHAGFORD, EXETER,

SUSSEX AND SUFFOLK TERTIARIES.

SIR,—1. In the course of the last summer I obtained from the Red Crag at Butley, near Chillesford, the following forms:

Pupa marginata, L.
Limnæa pereger, Müll.
,, *truncatula*, Müll.
Limnæa sp.
Planorbis complanatus, L.

All the above are new to the Red Crag except the last. They were intermixed with marine shells.

Resting on the London Clay in the coast near Felixtow, I found a freshwater river deposit, containing amongst other shells *Cyclostoma elegans* and *Helix aspersa*. The bed is overlain by about two feet of gravel, and that again by the surface soil. The river has undercut the Boulder-clay to a considerable extent on each side.

The bed is worth notice, as the evidence that the above shells occur fossil in Britain is very meagre.

2. To the Shells listed by Mr. Godwin-Austen from the Mud-deposit at Selsey, I can add the following, two being altogether new to Britain, but living with *Lutraria rugosa* and *Pecten polymorphus* in the Mediterranean, making four southern forms,only found in this deposit.

Pleurotoma (*Mangelia*) *rupa*, Montagu.
Littorina rudis, Mason.
,, *obtusata*, Linné.
Lacuna puteolus, Turton.
Rissoa parva, Da Costa.
,, *striatula*, Montagu.
,, *interrupta*, Adams.
,, *costulata*, Alder.
,, *membranacea*, Desmarest.
,, *striata*, Adams.
Hydrobia ulvæ, Pennant.
Odostomia plicata, Montagu.
,, *indistincta*, var. *suturnalis*, Philippi.
,, *pallida*, Montagu.
Trochus lineatus, Da Costa.
Trochus exasperatus, Pennant.
Adeorbis subcarinata, Montagu.
Solarium pseudo-perspectivum, Brocchi (New).
Turritella communis, Risso.
Utriculus obtusus, Montagu.
Patella vulgata, Linné.
Chiton marginatus, Pennant.
,, *fascicularis*, Linné.
,, *siculus*, Gray (New).
Anomia ephippium, Linné.
Ostrea edulis, Linné.
Cytherea chione, Linné.
Syndosmya tenuis, Montagu.
Saxicava rugosa, Linné.
Corbula gibba, Olivi.

For the determination of the more critical forms I am indebted to Mr. J. Gwyn Jeffreys. ALFRED BELL.

29, GRAFTON STREET, FITZROY SQUARE.

DISCOVERY OF *BOS PRIMIGENIUS* IN THE LOWER BOULDER-CLAY OF SCOTLAND.

SIR,—Mr. Geikie, in reply to my note on the above subject (in the October Magazine), reads a lecture on my assumed ignorance of what constitutes Boulder-clay—the gratuitous assumption cannot alter the facts of the case in question. If a Glacier has deposited the beds of sand and earthy clay that fill two small basins that overlie the stratified bed, in which the *Bos* was found, it must have been very different from the one that preceded the stratified bed. The latter has left evidence of its passage on the rocks of the valley; the former has left none on the soft mud-bed, over which it must have passed—this stratified bed being as smooth and undisturbed, as if newly deposited in a quiet lake. Not wishing to enter into a controversy with Mr. Geikie, I merely point out this fact for his consideration. ROBERT CRAIG.

LANGSIDE, BEITH, *Nov.*, 1868.

HETEROPHYLLIA MIRABILIS, DUNCAN.

SIR,—The tone of Dr. Duncan's reply, and his reference to my position, constrain me to decline further correspondence with him on this subject. My wish was to settle the determination of the coral in question, not the qualifications of palæontologists. The only points requiring notice in his remarks are, 1st., the assertion that irregular fracture of the spines is exceptional, and the assumption of anchylosis of the joint; and 2nd., that no one has a right to criticise his (Dr. Duncan's) work, who has not himself described fossils.

The first begs entirely the question, and the evidence I have adduced justifies me in disputing assertions, however authoritative.

The second requires only to be stated for its assumption to be apparent. JOHN YOUNG.

HUNTERIAN MUSEUM, GLASGOW,
December 5, 1868.

CLIMAXODUS OVATUS AND *DIPLODUS.*

SIR,—Since my paper on the new palatal tooth, *Climaxodus ovatus,* appeared in the GEOLOGICAL MAGAZINE for November, 1868, I have been fortunate enough to obtain three additional specimens.

The general characters of the new specimens are the same as those which I have already described, but their sizes differ and there is considerable modification in their general outlines. Two of the specimens present the front or ridged view, and one the back or curved view of the teeth. The body of the tooth which presents the back view is about 4-10ths of an inch in length and about 5-10ths broad, and the root or attachment of the tooth is a trifle longer than the body of the tooth itself. Of the other two teeth presenting front views, one is 6-10ths of an inch long and 5-10ths broad, and the entire length of tooth and root is 9-10ths; it is crossed by four distinct ridges. The next tooth is 11-20ths of an inch broad and 9-20ths long, and is crossed on its lower half by five closely arranged ridges, the root or process for attachment being 4-10 inch in length. The general structure and appearance of the teeth resemble those previously described.

In the October Number of the GEOLOGICAL MAGAZINE I offered to forward specimens of Coal-measure fossils to any of your readers who forwarded to me a stamped and addressed luggage-label. Several have forwarded labels and received their specimens, but others do not quite understand what I require to have sent me.

Allow me again to state that as I have thousands of duplicate specimens (of which it would be a charity to relieve me) of teeth, scales, ribs, vertebræ, spines, and other remains of *Rhizodus*, *Megalichthys*, *Gyracanthus*, *Pleuracanthus*, *Diplodus*, *Ctenoptychius*, etc., etc., I shall be most happy to forward per *Sample Post* a parcel *under four ounces* in weight to any of your readers who forward me an ordinary perforated luggage label, bearing their address and two penny postage stamps for return postage. If any of your readers cannot conveniently obtain a luggage label, their address and two postage stamps will answer the purpose, as I shall find the label.—T. P. BARKAS.

NEWCASTLE-ON-TYNE, *November*, 1868.

UNUSUAL FORMS OF *CTENOPTYCHIUS.*

Sir,—Among the numerous fossil remains which I have recently obtained from the shale overlying the Low Main Coal-seam in Northumberland, there are two peculiar forms of *Ctenoptychius*, which seem worthy of being illustrated and recorded in your pages.

The two species, *Ctenoptychius pectinatus*, and *C. denticulatus* are very abundant, but they are of the usual forms, with serrated upper edges, the serrations varying from eight to upwards of twenty in number, and the roots extending downwards from the body of the tooth or tubercle connected with the serrated edge.

Teeth of Ctenoptychius.

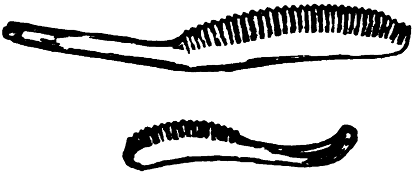

Fig. 1. With 33 Serrations (twice natural size).
Fig. 2. With 17 Serrations (three times natural size).

The two specimens to which I desire to direct special attention (see Woodcut) are the only two I have obtained with lateral instead of perpendicular extensions. There is in the two specimens an entire absence of the root-like processes which ordinarily characterise *Ctenoptychius*. The only extension from the serrated bodies of the teeth proceeds from one side, and the teeth present the appearance of miniature combs, with long, slender solid handles. I shall best convey an accurate idea of their sizes, forms, and general appearance by the annexed outline sketches. (See Woodcut above.)

I have just learned that several specimens in my collection from the Northumberland Carboniferous strata, which I have been ascribing to *Megalichthys*, are in reality *Parabatrachus*, a frog-like reptile, which was originally discovered in the Glasgow Coal-measures, and was described by Professor Owen in the Geological Journal, vol. ix. The glazed and punctured character of the head-plates bear a remarkable resemblance to those of *Megalichthys*; their forms, however, differ considerably. T. P. Barkas.

Newcastle-on-Tyne, *Dec.* 5, 1868.

ON A NEWLY-DISCOVERED LONG-EYED TRILOBITE FROM DUDLEY.

Under the above heading, I published an Article in the Geological Magazine for November last, p. 489, in which I described a specimen of *Calymene Blumenbachii* having long eye-stalks, obligingly lent me by Mr. E. Hollier.

On Nov. 3rd I received a note from Mr. Charles Ketley, of Smethwick, informing me that he knew the specimen, and that the so-called eye-stalks were, in his opinion, only parts of the underside of the head-margin of another Trilobite *in contact with,* but *not a part,* of the specimen described.

On Nov. 9th Mr. Samuel Allport, of Birmingham, wrote me almost to the same effect.

On Nov. 17th Mr. Henry Johnson, of Dudley, forwarded me a very long criticism upon my article, insisting strongly upon the same explanation of the supposed eye-pedicels as that already suggested by Messrs. Ketley and Allport in their letters, and he published the same letter in full in the "Dudley Guardian" of Nov. 21st.

A very animated correspondence ensued in that paper and in the "Herald" (Nov. 25th, Dec. 2nd and 5th) between Messrs. Hollier and Johnson. A gentleman signing himself "Student" added a letter, and I also wrote a brief reply.

I may state that the specimen was most critically examined by many of my scientific colleagues before I described it, and I found that several of them, upon a subsequent examination, still held to the opinion that the junction between the glabella and the supposed eye-pedicels could not be accidental, and was certainly not artificial; and moreover, that the surface of the glabella and that of the horns was at parts continuous, where not cut in developing.

Mr. Johnson states that the raised supraciliary margin of the true orbit was distinctly visible near the base of the pedicels when the Trilobite was shown to him by the workman before its final development.

The most dexterous artist could not have united the head and the horns to produce the effect seen in the specimen leaving the matrix unsullied as it is; but it was quite possible, by a few clever touches, to render the apparent union of the parts still more complete, and that is what really seems to have been done. Whether the portions which formed these so-called eye-peduncles are really the missing portions of the incurved under-margin of the genal-border of the head of the *same* Trilobite, *naturally* (*not artificially*) displaced, so as to project from the two orbital apertures; or, whether they were produced from the corresponding portions of the head of another individual, fortuitously brought in contact with it whilst the matrix was still soft and yielding, the effect produced is nevertheless very remarkable, and so like a true union of parts as to have misled other and far abler observers than myself.[1]

With regard to this Trilobite I have said in my paper (p. 490) that "In all points except in the remarkable eye-peduncles, the specimen appears to be a true *Calymene Blumenbachii.* Indeed there are specimens in the Museum collection which match Mr. Hollier's Trilobite most exactly, save in this one particular." The constant absence of the cornea of the eye in *Calymene* and the elevated border surrounding it, led me to conclude that in this, as in *Asaphus*, *Encrinurus*, &c., the eyes were raised on foot-stalks, which had been in this instance crushed downwards from their more erect normal position, and apparently carrying with them the genal portion of the head.

Henry Woodward.

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[1] See Report of Meeting of the Dudley and Midland Geological Society, p. 37,

ON THE ELEVATION OF MOUNTAIN CHAINS.

Sir,—In reply to the slight notice with which Mr. Scrope has honoured my speculation on volcanic action,[1] I can assure him that nothing was further from my intention than to claim as original what I had learnt from him. It was merely for the sake of brevity that I omitted a reference, which I thought every one could supply. When my paper was read, I used the words, "With respect to the raising of *ejectamenta* in a fissure, it is clearly proved by Scrope, in his work on volcanos, that the force to which it is due is the expansion of aqueous vapour when relieved from pressure." I regret that I did not transfer the sentence in full to your pages.

It will, however, be perceived that although I am indebted to Mr. Scrope for my ideas of the *nature* of a volcanic eruption, my speculation as to its *cause* differs from his theory.

He attributes the elevation of mountains and the trains of volcanoes which often accompany them, to local changes of temperature. "The results of such a local change of temperature would seem to be, first, the dilatation—whether or not amounting to fusion—and, consequent, upward pressure and bodily rise of the expanding matter beneath the centre or medial line of the area affected, but without producing its outward extravasation there; and, secondly, and at the same time, the upward rush and (sooner or later, probably) the external eruption of portions of this heated and fluidified matter through fissures formed towards the margin of the elevated area, and ranging in parallel lines on one or both sides of its central axis of maximum upthrust."[2] It appears, then, that the motive power, in Mr. Scrope's opinion, is the pressure from below of matter expanded by an accession of heat.

I, on the other hand, conceive the elevation of the mountains to be owing to the contraction of the general mass of the earth within its already cooled crust, and suspect a diminution of pressure beneath mountain ranges on account of their being partly supported by their lateral abutments. I conceive the diminution of pressure so caused to induce liquefaction of the subjacent plutonic mass; so that eruption takes place through vents prepared for it—not by the upward pressure of increasingly heated matter, as supposed by Mr. Scrope; but by the crumpling of the crust through lateral pressure caused by a general cooling of the globe. To my mind the difference between these views amounts almost to an interchange of cause and effect.

Harlton, *near Cambridge.* O. Fisher.

FISHER.—DENUDATIONS OF NORFOLK.

Sir,—Under this heading your number for December contains a paper by the Rev. O. Fisher. The opening sentence is—"Upon the land-surface a certain amount of the fine material is being carried into the rivers, and by them deposited at the heads of the Broads, or where such do not exist, in the sea. This denudation by *pluvial action* is undoubtedly greater where the land is under the plough than it would be otherwise." The wildest subaerialist will require nothing more than this. Grant this and time, and the entire land must be deposited beneath the sea. So far theoretically. Practically we know that it is so. Practically we know that the entire land has been under the sea. In fact, as I have headed a chapter in Rain and Rivers, "It is only fire that keeps our heads above water." Yet Mr. Fisher, who admits the principle that rain ever has been and actually is now washing the entire land into the sea, begins a sentence (page 557), "The windings of the valleys also appear to be on a larger scale than can be due to such rivers." Why the insignificant valleys which he mentions, nay, the largest valleys in earth, those of the Amazon, Yang Tze, and Mississippi might have been formed without any river at all, by atmospheric disintegration and the erosion of rain. That is, by the *pluvial action* mentioned by Mr. Fisher himself. When these rivers are flooded by rain they are swollen to perhaps twenty times their usual volume; and these rain-floods would occur annually in their valleys whether the rivers existed there or not. That is, instead of constant rivers there would be periodical rivers in the valleys. I have said in Rain and Rivers, that rivers are rain reappearing and returning to the sea. But Mr. Fisher talks of rivers as if they were not rain; and if not, what are they? Evaporation condensed into rain is the *causa causarum.* Rain causes valleys. The largest rivers in the world are by comparison, the effects of this *causa causarum,* and are mere assistants in forming the wondrously magnificent valleys in which they flow (for, perhaps, 4,000 miles), and which are the roads which carry the entire surface of the earth into the sea. This Titanic traffic is brought to them entirely by rain. That is, owing to atmospheric disintegration everything on the surface of the earth which is not living is decaying. Hence, soil; and soil, which is rotted subsoil, is in perpetual formation over the entire surface of the earth, and is perpetually washed down the hill-side into the valley, and along the valley into the sea.

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[1] Geol. Mag. Vol. V., p. 493.

[2] Scrope's Volcanos, 1862, p. 273.

Again, Mr. Fisher says, of what he improperly calls "The valley of the Waveney and the Little Ouse," "If the excavation of this valley had been produced by river-action it is inconceivable how it could have been excavated over the watershed." It is not asserted that the so-called valley is formed by "river action." It is asserted that the low water parting between the *two* valleys has been caused by what caused the two rivers—rain. Mr. Fisher begins with the broad and wholesome doctrine of *pluvial* denudation, here he comes to the narrow one of *fluvial* denudation. That is the doctrine of Sedgwick and Murchison, that denudation is only on lines on the lines of rivers, This is to confuse cause and effect. In joining "Rain and Rivers" together we must remember that rain is the cause, rivers the effect. In a chalk country like Norfolk there is not a single so-called river valley which does not begin with a dry valley, or "rain valley," far above the highest springs of the river. Two opposite rain valleys constantly cut nearly through the dividing ridge. But as long as a water parting remains, and the waters run in opposite directions, we must consider them as two valleys. Mr. Fisher talks of the valleys of the

Waveney and Little Ouse, first as one valley, then as two valleys, then as two valleys inosculating. But the upper part of every so-called river valley on earth is always purely a "rain valley or dry valley" *sine flumine vallis*, as in myriads of cases *entire* valleys are, especially in porous-strata like Chalk. And in nature, at the dividing ridge, each opposite dry valley or water-flow may be seen to stretch its fingers up each opposite water-slope to join hands across the intervening water-parting. Hence the low parts of a dividing ridge alternating with high parts, for which we have the modern northern terms, gap, saddle, col, &c. Hence the southern sierra or serra (saw), and the Latin "juga montium," from the saw-like, or yoke-like ups and downs of dividing ridges. The very name of jugum (hill or yoke) originates here, But these opposite dry valleys, which run up to these low parts of the dividing ridge, these beginnings of valleys are not caused by rivers. They are caused by the cause of rivers—rain.

George Greenwood, Colonel.

Brookwood Park, Alresford, *December* 7, 1868.

THE MAMMALIA OF THE CRAG.

Sir,—I observe that the Rev. O. Fisher, at page 547 of your last number, states, on the authority of the Rev. J. Gunn, that *Elephas meridionalis* occurs in the Red Crag. He also speaks of the "Crag period" in such a way as to make it clear that he regards the terrestrial Mammalian fauna of the Suffolk Bone-bed as identical with that of the Mammalian Norfolk Crag. It has always been to me a matter for much regret that the able students of the Norfolk Crags will not give due attention to the facts known as to the Suffolk Crag, for by their assistance the students of the latter might hope to unravel the mysterious history of that strange deposit, the Red Crag. What grounds have the Rev. John Gunn and the Rev. O. Fisher for stating that *E. meridionalis* is found in the Red Crag? The only elephant tooth supposed to come from the Red Crag—known to the late Dr. Falconer—is referred by him to *E. antiquus* (Palæont. Mem. vol. ii. p. 181), and there is no real reason for believing it to be a Red Crag specimen at all. It is true that *Mastodon Arvernensis* is common to the Norfolk and Suffolk deposits; but have you in Norfolk *Rhinoceros Schleiermacheri*, *Hyæna antiqua*, *Hipparion* (*Ursus arvernensis* is, I think, found there)? Though the character of the lowest beds of the Suffolk and Norfolk deposits is similar, there seems to me, at present, reason to regard the terrestrial Mammalian fauna of the Suffolk Bone-bed as older than that of the Norfolk Crag generally. It is most important to remember that they are *older than the Coralline Crag.*

E. Ray Lankester.

ON THE OCCURRENCE OF TITANIUM, ETC., IN MAYO.

Sir,—I have lately discovered a new locality for the mineral Titanium, viz., on Cushcamcurragh, a mountain in the townland of Treel, near Newport, Mayo. It occurs in the form of fine crystals of Rutile, imbedded in quartz and schist, in the neighbourhood of a landslip of considerable extent which took place last year at the of the Glenthomas valley. The greater part of the specimens obtained were from its surface, and associated with a small variety of schorl; it also occurs under similar circumstances on the east side of the ridge above the landslip, on the surface of some smaller slips Magnetic iron likewise appears on the weathered surface of some neighbouring rocks, of which I procured some fine specimens, and near the west summit of the mountain I found a peculiar form of Andalusite. Few crystals of Titanium are to be obtained, except amongst the debris of the above localities, scarcely any being observable amongst the numerous outcrops of the adjoining strata.

The crystals of Rutile are in colour red or dark metallic brown, frequently geniculated, and occasionally of considerable size. A specimen which I presented to the Museum of the Royal Dublin Society was nearly 4 inches in length and in width about ¾ inch. I have also given specimens to the Museums of Trinity College, and of the Geological Survey of Ireland.

Titanium is probably widely disseminated in minute quantities through the mountains north of Clew Bay, though rarely occurring as a distinct mineral. Traces of iron may frequently be observed. and minute crystals of schorl as well as a specimen resembling rutile I noticed near Birreencorragh, but nowhere in the district have I found these minerals in such development as on Cushcamcurragh.

S. G. PERCEVAL.

HENBURY, *Nov.* 25*th*, 1868.

SUPPOSED PHOLAS-HOLES ON CONWAY MOUNTAINS.

SIR,—In a letter, printed on p. 377, Vol. IV., GEOL. MAG., Mr. Maw cites the information of a friend who had seen Pholas-borings high up on the mountain to the west of Conway. In answer to an application, the observer has kindly mentioned his locality to me, describing the holes as "of two species, very numerous, the rock being one mass of holes, large and small, ... honeycombed in every direction, like a sponge." The place is a small quarry, on the north side of the very ridge of Conway mountain, and may be best reached by climbing the hill straight up from the Bangor Road, at the west side of a gravel quarry, at the foot of a huge round-headed rock westward of the Railway Bridge there.

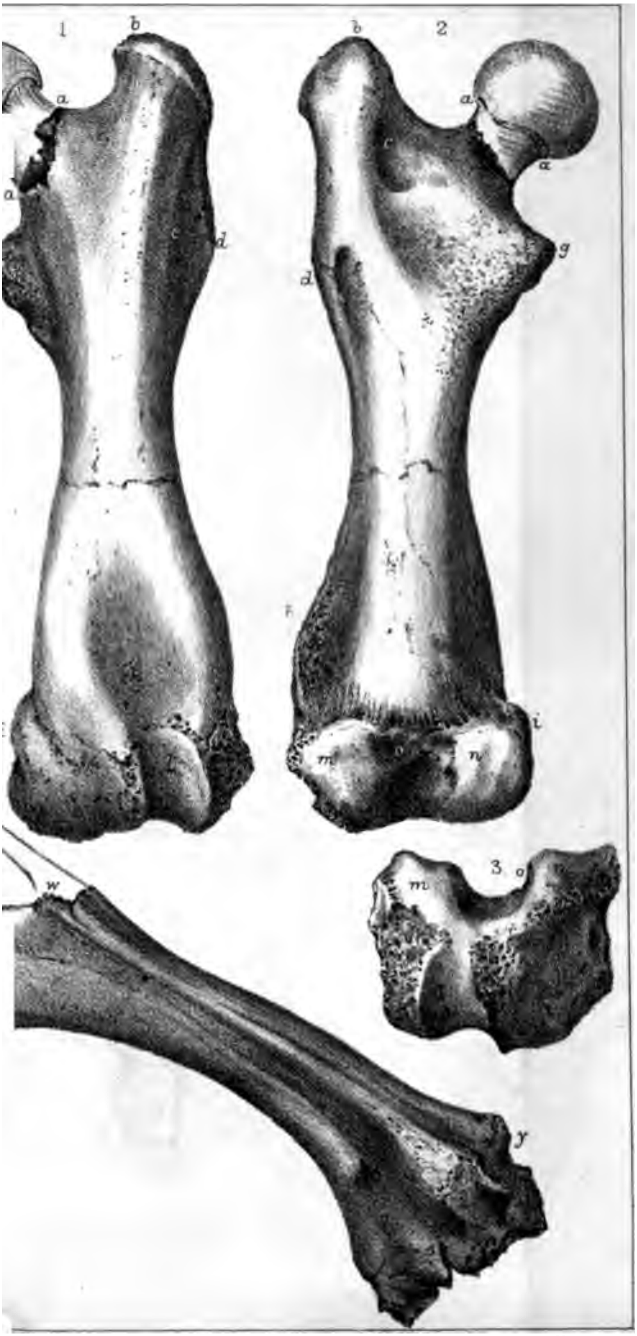
As the observation seems to have been too hasty, I will beg you, in order that it may not lead to misapprehension, to insert this note.

The so-called Pholas-holes are not the work of any animal. They occur throughout the rock, and not on the surface only. The rock is a vesicular felspathic trap, with many larger or smaller oval cells, most of which are lined with a laminar deposit of crystalline matter. Some portions of it are honeycombed, others full of communicating holes, so as to look not very unlike coarse sponge. The larger holes in exposed places, with thin laminar lining, have weathered, so as to present a considerable likeness to Pholas-holes with shells in, but inspection will at once prove their purely mineralogical character.

R. D. DARBISHIRE.

26, GEORGE ST., MANCHESTER, 4*th Dec.*, 1868.

Vol VI. Pl. III.



W. West imp.

r Forest-bed.

THE

GEOLOGICAL MAGAZINE.

No. LVI.—FEBRUARY, 1869.

ORIGINAL ARTICLES:

I.—On the Distinction between *Castor* and *Trogontherium*.

By Professor Owen, F.R.S., etc.

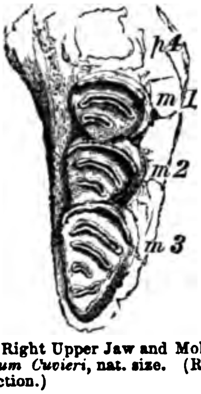
(With a Double Plate, III.)

A COMPARISON, with corresponding parts of existing species of *Castor*, of specimens of mandible and mandibular teeth of a large beaver-like quadruped, obtained from the fresh-water deposits called the 'Forest-bed' on the Norfolk coast, led me, in 1845, to the conclusion signified by the adoption of Fischer's generic appellation, *Trogontherium*, for the rodent, which seemed to exemplify "an extinct sub-generic type" of *Castoridæ*.[1]

Subsequent acquisitions of a femur from the Forest-bed at Mundesley, by the Rev. John Gunn, M.A., F.G.S., and of a tibia from the same formation and locality, by the late Rev. S. W. King, M.A., F.G.S., together with portions of upper jaw with teeth, have yielded confirmation of the above conclusion.

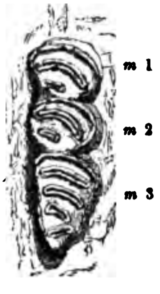
The teeth in the portion of upper jaw in Mr. King's collection (Fig. 1), answer to the second (*m* 1) and third (*m* 2) right side of the beaver: part of the alveolus, and the root of the first grinder (*p* 4),

Fig. 1.



Portion of Right Upper Jaw and Molar Series, *Trogontherium Cuvieri*, nat. size. (Rev. S. W. King's Collection.)

Fig. 2.



Copied from Cast of Molar Series of *Trogontherium Cuvieri*, from the Department de l' Eure et Loire.

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[1] "British Fossil Mammals," 8vo. p. 184.

indicate a proportionally large size of that tooth, repeating that characteristic of the homotypal grinder in the lower jaw (Fig. 3, *p* 4). Only the first half of the crown of the last upper grinder is in place, but the socket indicates a greater posterior prolongation of this tooth than in *Castor*: and a cast of the last three upper grinders (*m* 1, *m* 2, *m* 3) of the *Trogontherium* found in lacustrine marl, in the 'Department de l'Eure et Loire.' Fig. 2, (added to my Fig. 1, at *m* 3), shows the angular posterior production of *m* 3, which generically differentiates *Trogontherium* from *Castor*: it is associated, as we shall see, with many corroborative modifications, if of minor value, in other *Trigontherium* fossils. The molars (*m* 1 and *m* 2) in Mr. King's specimen, from Mundesley, have a transverse section, or grinding surface, more triangular than in *Castor*: the inner side of the tooth is narrower and more rounded, not bilobed. The peripheral enamel is continued along that side, uninterruptedly, becoming thinner as it curves to the back part of the tooth. In *Castor* the inner enamel-wall is bent into the substance of the tooth near the middle of the inner surface, forming a fold, which extends nearly half-way across toward the outer surface.

The well-marked difference, in this respect, between the upper grinders (*m* 1, *m* 2), of *Castor* and those of *Trigontherium*, is not due to different degrees of attrition; for the inner longitudinal groove produced, in *Castor*, by the fold above-mentioned, is co-extensive in that genus with the length of the enamelled crown.

In *m* 1 and *m* 2 of *Trogontherium*, there comes next, behind the anterior enamel-wall, a narrow and long insular fold of enamel curving across the crown nearly parallel to that wall, but slightly receding from it, as the island extends from without inwards; the ends of the island touch, or nearly so, the peripheral wall of enamel. There is no such narrow enamel-island curving from the outer to the inner side of the front half of the molar in *Castor*; it is represented by an outer fold which passes inward in front of and beyond the blind end of the inner fold above described, together with that fold, in *Castor*. Behind the anterior enamel-island, in *Trogontherium*, there is a second shorter island, sub-parallel therewith, commencing from, or close to, the outer wall, and terminating opposite the middle of the posterior border of the grinding surface. In *m* 1 and *m* 2 of *Castor* there are two folds of enamel penetrating from the outer side, the anterior of which extends to near the inner and hinder angle of the grinding surface. The last upper molar of *Trogontherium* has the second transverse island parallel and co-extensive with the first, with a third and a fourth shorter transverse fold or island; the grinding surface is triangular, with a curved or convex anterior base; the fore-and-aft extent equals that of the two preceding grinders. In *Castor* the dimension of *m* 3 is less than that of the contiguous molar, *m* 2, and its grinding surface, instead of being more, is less complex.

The lower molars, *p* 4,[1] *m* 1, *m* 2, of which the grinding surface is figured of the natural size in my "British Fossil Mammals," p. 189, fig. 73, are from an aged individual, with crowns worn down to near the base. As both *m* 1 and *m* 2 were in place and use before *p* 4, they show the effects of attrition in a greater degree.

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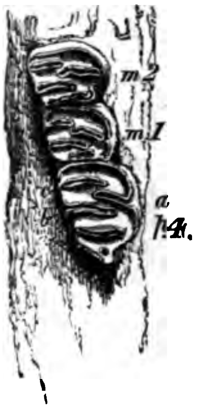
[1] There seems to be more loss than gain in reversing the usual way, viz., from before backward, of counting teeth; and so I retain my method of considering the

In this portion of lower jaw obtained by Mr. King from the Forest-bed at Mundesley, and the remarkable similarity of which to the figured specimen from Cromer[1] is noted by my accomplished and much lamented friend, the degree of wear is less, and the character of the grinding surface of *m* 1 and *m* 2 is better shown.

The outer side of the crown is not indented, so as to become bilobed, as in *Castor;* the fold of enamel which extends from the outer side half-way across, and corresponds with the wider fold dividing the lobes in *Castor*, begins more abruptly, and as a closer fold, of the outer enamel-wall; and, as the fold or in-doubling is not continued so low down the outside of the crown in *Trogontherium*, the fold is sooner separated from the outer enamel-wall, and appears as a narrow, slightly bent island, curving from the outer, obliquely backward, half-way toward the inner side of the crown. Anterior to this fold are two narrow enamel-islands: one begins close to the inner enamel-wall, or as an infolding of that wall, and runs parallel with the outer fold or island, more than half way to the outer side. In advance of this is a narrow island of enamel near to the anterior enamel-wall, with the ends equidistant from the outer and inner borders of the grinding surface; this island is nearly obliterated in *m* 1; as it was wholly so in the Cromer specimen (fig. 73, op. cit.) Behind the first-mentioned island or fold, from the outer surface, is one from the inner surface, extending parallel with the posterior enamel-wall rather more than half-way across the tooth; this last coronet fold is quite insulated and shortened in *m* 2 of the Cromer specimen, and has disappeared from *m* 1.

Fig. 3.



Portions of Left ramus Lower Jaw, (*Trogontherium Cuvieri*,) nat. size. Rev. S. W. King's specimen.

This anterior grinder, 4, *p* shows an insular remnant of an enamel fold anterior to the four long islands or folds in fig. 73, Brit. Foss. Mamm., and a rather more produced and narrower anterior termination of the crown than in the specimen of the older *Trogonthere* from Cromer.

It is remarkable that the hindmost grinder should be wanting in the five examples of mandible, including the more perfect specimen

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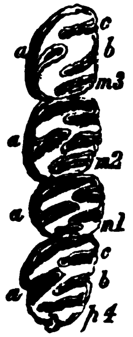
hindmost of the pre-molars, like the hindmost of the true molars, as the last of its series, which in *Diphyodonts* is the fourth. The order in which both kinds of teeth follow one after another, viz., from before backward (if there be an interval in appearance), also weighs with me in rejecting Rutimeyer's innovation of counting the hindmost and last appearing milk-molar and pre-molar, as the "first" of their respective series. — "Beiträge zur Kenntniss der fossilen Pferde," in "Verhandlungen der Natur-forsch. Gesellsch. in Basel," Bd. iii. Ht. 4, 1863.

[1] Brit. Foss. Mamm. p. 186, fig. 72.

from Bacton (fig. 71, Brit. Foss. Mamm.); and in 1845 I could only remark, in regard to *m* 3, that its socket shows it to have had a larger antero-posterior diameter than the antecedent grinder, corresponding with the character of its homotype above, both molars showing proportions the reverse of those in the genus *Castor*. In my last visit to Norwich, I found in the well-known collection of Robert Fitch, Esq., F.G.S., which was opened to my inspection with that gentleman's usual liberality, a portion of the right ramus of the mandible of *Trogontherium*, from the Forest-bed at Mundesley, having the series of four grinders complete. The specimen was also from a younger individual than those I had previously seen, showing rather larger dimensions of *m* 1 and *m* 2, which slightly contract toward the roots, and affording a more perfect condition of the enamel character. In *p* 4, the small anterior island of Fig. 3 retains (*b*) its character as a short fold from the outer part of the anterior end of the tooth. The beginning of the outer submedian fold, *a*, is rather wider, the continuation of the two inner folds, *b*, *c*, with enamel-wall is more distinct. This beginning of the folds *a*, *b*, *c*, is also manifest in *m* 1, and *m* 2. In *m* 3, the two minor folds, *b c*, diverge from each other as they penetrate the tooth more than in the other grinders; the outer fold *a* inclines more obliquely backwards; there is an indication of a very short bend of the enamel-wall at the produced and rather contracted hind-end of *m* 3. In all the teeth the anterior long and narrow enamel-island is shown; and in *m* 2 and *m* 3 are indications of its being an infolding from the inner enamel-wall. In *Castor* the last grinder of the mandible, like that of the maxilla, is smaller than the rest, which, with the difference of pattern of the grinding surface of all the molars, gives ground for generic distinction of the great Castorine rodent of the Forest-bed, as good as for any accepted genus of the order.

Fig. 4.



Grinding Surface of the Molar Series, Right Side, Lower Jaw, of *Trogontherium*, nat. size. (Mr. Fitch's specimen.)

The outer part of the mandible in *Trogontherium* is much more prominent or convex below the small crotaphyte fossa than in *Castor*. The rough surface for insertion of masseter extends to beneath the anterior grinder, *p* 4; in *Castor* it does not advance beyond the interspace between *p* 4 and *m* 1.

A distal epiphysis of a right humerus, obtained by Mr. Gunn from the Forest-bed of Mundesley, indicates a larger proportional size of the fore-limb in *Trogontherium* than in *Castor*. The radial convexity of the trochlea has more fore-and-aft extent in *Trogontherium*; its contour is nearly that of an equilateral triangle, with the sides rather convex: in *Castor* the transverse diameter of the radial convexity much exceeds the antero-posterior one. The ulnar channel is much deeper in *Trogontherium* than in *Castor:* the posterior or olecromal part of the pulley is relatively wider and shallower in *Trogontherium*.

In an old British beaver (*Castor fiber*), from a Cambridgeshire fen-deposit, the breadth of the olecromal part of the articular trochlea of the humerus is 0·010 = 5 lines; in *Trogontherium* it is 0·023 = 10½ lines. The breadth of the fore part of the trochlea in *Castor* is 0·019 = 9 lines: in *Trogontherium* it is 0·024 = 11½ lines; the antero-posterior diameter of the radial tuberosity of the humeral trochlea in *Castor* is 0·008 = 4 lines; in *Trogontherium* it is 0·020 = 9 lines.

The femur, Pl. III. Figs. 1 and 2, was obtained by the Rev. John Gunn, M.A., F.G.S., from the Forest-bed, at Mundesley. A faint trace of the distal epiphysial line indicates it to have belonged to a young, but nearly, if not quite, full-grown animal. The processes, ridges, rough pits, etc., indicative of muscular insertions and actions, are well-marked.

Among the characters of the femur in the order *Rodentia* may be noted, a slender femoral neck, high trochanter major with deep trochanterian fossa, well-marked trochanter minor, a third trochanterian process or ridge, distinctive of the rotular articular surface from that of the condyles. These characters do not concur in every rodent femur, but are found in most. They are present in the fossil in question; the third trochanter being represented by a long ridge, Fig. 1, *e*, *d*, but the present bone has not the ordinary cylindrical shaft of the rodent femur, being rather flattened from before backward, and expanding transversely at the distal half.

The above characters sway me to the conclusion that the specimen in question is the femur of a large rodent quadruped; the shape of the shaft, and other characters presently to be noticed incline me to refer such rodent to the beaver-family (*Castoridæ*). Hitherto, no evidence of a large rodent animal has turned up in any locality of the Norfolk littoral Forest-bed, save that to which the teeth and portions of jaws above described or referred to, belong, viz., the *Trogontherium Cuvieri*. I, therefore, deem it highly probable that we have in Mr. Gunn's unique specimen (now, by the liberality of that acute and persevering investigator of the geology and fossils of the Norfolk coast, in the Museum of the town of Norwich) evidence of a part of the skeleton, of the rare and interesting extinct *Castorine* animal, hitherto unknown and undescribed. This probability may engender in others, as in myself, a strong belief, if not conviction, from the correspondence of the degrees of resemblance and difference which the femur in question presents, with those presented by the dentition of *Trogontherium* in the comparison with the beaver (*Castor Europæus*), in which belief I assign this bone to *Trogontherium*.

The cervix femoris (Pl. III. Fig. 1, *a*, *a*.) is slender and sub-compressed from before backward, the little that remains (the head being broken off) indicates it to have inclined forward as well as upward and inward, like the cervix femoris of *Castor*. The trochanter major (ib. *b*), is a lofty three-sided process, with a large, rough, convex summit, as in *Castor*, but it is relatively shorter, with a broader base, and a deeper post-internal fossa (ib. *c*) Below the fossa a low ridge extends towards the trochanter minor (ib. *g*), which

is as much developed as in *Castor*, but is more triangular in sl
less thickly and obtusely terminated than in *Castor*. The chief
ference, however, is in the third trochanter, which in *Trogonthe*
is represented by a ridge (ib. *e*, *d*), continued from the outer pa
the base of the trochanter major downward and slightly backw
subsiding before attaining the mid-length of the bone, a little be
the outer border of the shaft at that part. In *Castor* the co
ponding ridge is thinner, sharper, and extends directly outw
thickening and projecting as an obtuse anteriorly bent pr
from the mid-half of the outer side of the femur, a ridge is
tinued down from the base of the process to the ectocond
tuberosity. In *Trogontherium* there is a channel (Fig. 1, *e*) a
the fore part of the ridge *d*, that causes its free border to c
forward, though in a less degree than in the process of the bea
thigh-bone. There is also a depression indicative of muscula
sertion at the back of the third-trochanterian ridge (Fig. 2,
Trogontherium. After the subsidence of this ridge, the shaft o
femur is free from ridges, etc., for the extent of nearly an i
yielding from its compression, a transverse irregularly oval sec
No part of the shaft of the beaver's thigh-bone is in this condi
like the mole's humerus it is invaded from end to end by outst
ing processes or ridges.

The outer border of the distal third of the femoral shaft of *Tr*
therium assumes by its expansion and posterior excavation (Fig.
the character of a ridge, but much thicker and more obtusely te
nated than in *Castor*, in which the well-defined posterior "musc
depression is wanting. The inner side of the distal third of
femoral shaft retains the transverse convexity to the entocond
tuberosity (Fig. 1, *i*.); in *Castor* it is produced and thinned off
edge; the tuberosity is alike in both, but a little more defined
the shaft in *Trogontherium*. Above the rotular canal there is a
smooth depression (Fig. 1, *k*.) in *Trogontherium*, scarcely a tra
which exists in *Castor;* the rotular canal (Fig. 1, *l*.) has the
breadth and outer inclination as it descends, in both. In both,
its articular or synovial surface is detached from that of either fen
condyle, though nearest to the outer one, *m*. As the distal e
the femur is relatively less expanded than in *Castor*, the ro
canal is broader in the like relation in *Trogontherium*. The post
intercondyloid channel (Fig. 2, *o*) is deeper and narrowe
Trogontherium.

I am not cognisant of such differences in femoral structure in
species of any genus of Rodent, now accepted in Mammalogy;
regard those above specified as concurring, with the dental differe
in establishing the genus *Trogontherium* in the Castorine grou
also infer from the femoral modifications, that the *Trogontheria*
less aquatic and a swifter mover upon land than the Beaver.
inference has some support from the characters of the tibia; f
the present femur have attained or nearly attained its full-le
wanting only consolidation or complete confluence of its distal
physis, it is shorter in proportion to the tibia than in *Castor*.

The tibia of *Trogontherium* (Pl. III., Figs. 4, *p*, *y*, 5 and 6), besides the superiority of size as belonging to a Rodent larger than the European or Canadian beavers, differs in the much less depth of the cavity (Fig. 6, *r*), impressing the back part of the proximal half of the shaft: in the thicker and more obtuse inner (tibial) border (*s*) of that concavity: in the stronger antero-posterior sigmoid flexure of the entire bone: and the greater extent of the confluent distal ends of tibia and fibula (*w*, *y*). The *medullarterial canal* (Fig. 6, *v*) has a similar position and direction. The anterior ridge (Fig. 5, *p*) is thicker and subsides sooner in *Trogontherium:* the outer concavity (*u*), and inner flat or subconvex surface, resemble those in *Castor*. The inner malleolus is longitudinally grooved as in *Castor;* its back part (*z*) is produced: the outer malleolus (*y*) projects a little above the distal articular end of the fibula.

Calcaneum, Pl. III., Fig. 8. The calcaneum in both *Castor fiber* and *Castor canadensis*, Fig. 9, is remarkable among rodents, for both the considerable length and breadth combined, of the hind or fulcral process, which, with the articular part of the bone placed horizontally for renewing and supporting a superincumbent vertical tibia, is so inclined as to seem to be flattened vertically (depressed), rather than from side to side (compressed).[1]

From the "Forest-bed" of Mundesley, Mr. Gunn obtained a calcaneum (left) of this castorine type, (Pl. III, Fig. 8), equalling that bone of a full-sized beaver in length, but exceeding it in breadth. I assume it to belong to the *Trogontherium*. The articular part of the bone presents two surfaces superiorly *a*, *b*, for the astragalus, and part of the larger anterior surface, *c*, remains on the fossil for the cuboides. The outer and upper surface, *a*, is longer and narrower in *Trogontherium* than in *Castor*; the inner process, *b*, is simply concave, not also convex, and flat posteriorly, as in *Castor*. The fulcral process, *d*, is broader and thicker, relatively much broader to its length, since in *Trogontherium* the bone is equally divided between its articular and fulcral parts, whereas in *Castor* the latter is the largest. In *Castor* the inner and lower border of the fulcral part is almost straight in *Trogontherium* by the inclination of the tendinal canal to the under and fore part of the bone; the inner border of the fulcral process is somewhat convex. The specific difference is obvious at a glance; the degree of the difference brought out by detailed comparison suggests a generic distinction concurring with that demonstrated by the dentition of *Trogontherium*.

The original or type specimen of *Trogontherium* has been described and figured by Dr. C. Rouillier, in his "Jubilæum Fischeri," p. 35, Tab. 5. It was discovered at Taganrog, Sea of Azoff.

In the "Quarantine Ravine," near Odessa, in a yellow argillaceous deposit, beneath a thick stratum of "Calcaire d'Ossessa," the "Old Caspian Deposit" of Murchison, various mammalian fossils[2] were discovered in 1846, among which were "parties separées de squelette (not specified) d'un animal resemblant au *Castor* (*Trogontherium*)."[1]

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[1] Catal. of Osteol. in Surgeon's College, 4to, No. 2193, p. 392.

[2] Elephas, Rhinoceros, Cervus, Equus, Hyæna, Ursus.

DESCRIPTION OF THE DOUBLE PLATE III.

Trogontherium Cuvieri.

Fig. 1. Front view of left femur.
2. Back view of *ib.*
3. Distal articular surface, or condyles, *ib.*
4. Outer side view of femur and tibia (the latter drawn without reversing.)
5. Front view of right tibia and confluent part of fibula.
6. Back view of *ib.*
7. Distal articular end of *ib.*
8. Calcaneum.
9. „ of the recent *Castor fiber* (for comparison).

All the figures are of the natural size.

II.—Notes on the Geology of the Lake District.

By J. R. Dakyns, of the Geological Survey.

I WISH, through the medium of your pages, to call the attention of Geologists to an important point in the Geology of the English Lake District.

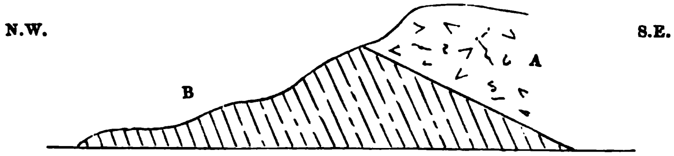
I made a short tour in that district early in December of last year, when I thought I discovered evidence of an "unconformity" between the beds of the Greenslates and Porphyry series and the Skiddaw Slates.

I walked from Keswick to Buttermere in company with another geologist, whose name I do not feel at liberty to mention, as I could not get him to agree with me in the view I took of the relation of the two sets of beds to one another.

We went by way of Littledale, and crossed the watershed between Robinson and Hindscarth, both of which hills we found to be composed of *Skiddaw Slates*, and *not* (*as wrongly coloured on* Ruthven's map, edition of 1855) of the *Porphyry series.*

When standing on the watershed overlooking the Buttermere valley, and facing Honister Crag, due south of us, I noticed and pointed out to my companion that the beds of the Crag, which are of the Porphyry and Greenslate series, appeared to lie at a low angle of, perhaps, 30° on the Skiddaw Slates, which on our or the north side of the valley, had their normal dip and strike of from 50° to 70° to the S.S.E., and appeared to have the same on the opposite side.

Fig. 1.—Rough Sketch of Honister Crag, Buttermere Valley.



A. Greenstone. B. Skiddaw Slates.

The appearance presented seemed to be of the character shewn in

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[1] Nordmann, Découverte de gîtes riches en Ossemens Fossiles, faite in 1846; Odessa, 8vo., 1847, p. 2.

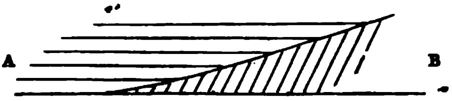
Fig. 1, where A. represents the Greenstone of Honister Crag lying on the upturned and denuded edges of the Skiddaw Slates (B.); though, as I was not able to examine the rocks on the spot, the appearance may have been deceptive from the effect of fore-shortening.

It put into my head, however, the idea of an unconformity, which I expressed to my companion.

The next excursion bearing upon the question I made alone.

I mapped the line of junction between the Skiddaw Slates and overlying series from near Lowdore, by Grange in Borrowdale, across the western fells by Eel Crags up to Dale Head.

Fig. 2.—Borrowdale Fells.



A. Greenstone. B. Skiddaw Slates.

In ascending the fells from Borrowdale, I distinctly made out that continually higher and higher beds of the Greenstone series abutted against the Skiddaw Slates, as shewn in Fig. 2, where A. represents the Greenstone lying unconformably on the Skiddaw Slates (B.), and the higher beds of Greenstone overlapping the lower. How far this extended I had not time to make out, but, probably, not far, as Professor Ramsay tells me that he never saw such an unconformity among the old rocks on a large scale.

It also seemed to me that not only were the Upper Beds lying at a comparatively low angle of perhaps 30 deg. on the denuded edges of the highly inclined Skiddaw slates, but that their strike was also different, Unfortunately I had not time nor favourable weather for satisfying myself on these important but minor points.

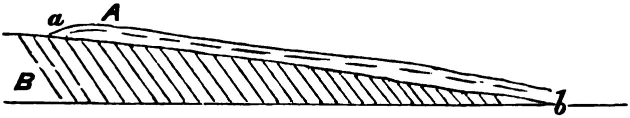
The line of junction between the two sets of beds crosses the ridge at Castle Nook.

I walked southward from that point along the top of Eel Crags, and got into the next valley between the southern end of those crags and the cliffs of Dale Head, and there to my surprise and joy, I found the Skiddaw Slates in place, with their normal dip and strike of 70 deg. to S.S.E., more than a mile south of Castle Nook, and not more than 500 feet lower, if so much. As the line from Castle Nook to this point runs but little west of south, it is manifest that unless the Skiddaw Slates change their strike between those points from a general east and west to a general north and south direction, or undergo some roll, of neither of which changes did I see any evidence from my various points of view, the upper beds must be resting unconformably on the lower, unless the Greenstone is intrusive, of which also I saw no evidence, but rather the reverse, for I believe it to be distinctly *bedded*.

It has been suggested to me that I may have mistaken cleavage for bedding in the Skiddaw Slates; but I considered that point at the time. My reason for thinking the planes to be bedding and not cleavage planes is, besides the fact that they looked to me much more like bedding than cleavage, that I saw them rolling about and contorted in places, which, if I am not mistaken as to the fact, is conclusive against their being cleavage.

NOTE.—I subjoin a third figure to show the lie of the beds along Eel Crags.

FIG. 3.—LIE OF THE BEDS ALONG EEL CRAGS.



A. Greenstone. B. Skiddaw Slates.

In Fig. 3, (A) represents the Greenstone lying on the Skiddaw Slates (B); the line *a b* separating the two sets of beds, makes an angle of 6° with the horizon; the Skiddaw slates are shown dipping at 60°, as their full dip is not seen.

III.—MAN AND THE MAMMOTH; BEING AN ACCOUNT OF THE ANIMALS FOUND ASSOCIATED WITH EARLY MAN IN PRE-HISTORIC TIMES.[1]

By HENRY WOODWARD, F.G.S., F.Z.S., of the British Museum.

HAVING a short time since drawn up a brief statement of the evidences upon which the presumed antiquity of the human race in Western Europe is based, and also some account of the animals found associated with early man in this region, I have ventured to think it may be found of sufficient interest to lay before this Society.

It is based only in a very small part upon my own observations, being chiefly composed of materials gathered from the published labours of my friends and colleagues, who have specially devoted their time and energies to these researches.

The question of primeval man and his contemporaries is now, by common consent, admitted to be one of the most important geological topics which has occupied the attention, not only of men of science, but also of the educated classes generally, in the present day, and notwithstanding the works already published, it may be said that the public mind is still craving for fuller information.

Nor need that craving remain altogether unrelieved, for every month contributes its quota to the general store of published facts and discoveries, and we may ourselves add thereto by careful observations in our own district if we only know how, when, and where to observe for ourselves.

The class of deposits which have yielded the evidence of which I am about to speak, cannot be said to have been altogether previously unnoticed, but it is only during the past ten years that the painstaking, careful investigations of such men as Prestwich, Falconer, Lubbock, Lartet, Christy, Pengelly, Evans, Boyd-Dawkins, Sanford, Dupont, and others of the same high stamp, have resulted in the real discoveries and vast additions to our knowledge of this last chapter of geological history heretofore unwritten, and in which Man and the Mammoth take part.

[1] This paper was read before the GEOLOGISTS' ASSOCIATION, on January 1st, 1869, and is printed here by permission of the Council.

Let us for a moment retrace the course of these events. So long ago as 1823, that distinguished British geologist, Dr. Buckland, published his celebrated work, the "*Reliquiæ Diluvianæ,*" in which he described the organic remains contained in ossiferous caverns and fissures, and "diluvial gravel" in various parts of Europe. But the Dean, although so acute a geologist, concluded that none of the stone implements or human remains met with in these deposits could be considered to be as old as the Mammoth and other extinct and foreign animals, with the bones and teeth of which they were associated.

So little was the study of Geology then understood, that the idea of any remains of man being found in deposits older than those attributed to the Noachian deluge was rejected as contrary to Scripture, and generally received opinion.

At this early period, however, 1824, the late Rev. Dr. John Fleming, F.R.S.E., at that time a minister in the Scotch Presbyterian Church, (afterwards Professor of Natural Philosophy in Aberdeen, and latterly Professor of Natural History at New College, Edinburgh,) contributed an article to the "Edinburgh Philosophical Journal," vol. xi., 1824, "On the Influence of Society on the Distribution of British Animals," in which he ably argued against the views of Dr. Buckland, and showed (even from the then comparatively scanty evidences) that there was incontestible proof of the contemporaneity of the human and animal relics found associated together in these cave-deposits, and that they were clearly the remains of the former denizens of the same region, entombed in their present burial places by similar causes to those now in action, and not by any wide-sweeping catastrophe, such as was assumed by the advocates of a universal deluge.

There was (1824-5) a highly intelligent Roman Catholic Priest living at Torquay, the Rev. J. McEnery, who, having examined a certain cavern, known as "Kent's Hole," discovered flint implements of undoubted human workmanship associated with bones of the Mammoth, the tichorhine Rhinoceros, cave-bear, and other mammalia, about the contemporaneity of which he does not seem to have doubted, and the correctness of whose views have been now well-established by subsequent investigation.

The next (1833–4) earliest systematic work of exploration we find was carried out in the valley of the Meuse, Belgium, by the late Dr. Schmerling, of Liége, who carefully searched for and exhumed the fossil human and animal remains buried together in the ossiferous caverns around Liége, an account of forty of which he published, with figures and descriptions of their buried contents.

In 1841 M. Boucher de Perthes commenced to collect, and, in 1847, to publish the result of his researches in the gravel-deposits of the valley of the Somme, around Abbeville, and the sight of his collection of flint-implements induced Dr. Rigollot to search the gravel-pits around Amiens, which also yielded singular proofs of prehistoric man. Notwithstanding the publication of these discoveries, however, public interest was not as yet aroused, and the French savans of Paris only laughed at Monsieur de Perthes and his researches.

Meanwhile English geologists were accumulating facts and material, which only needed some fresh motive force to give it vitality and importance, and it came at last after long years of waiting.

To the late Dr. Hugh Falconer, F.R.S., we no doubt owe the initiation of a new era in the investigation of ossiferous deposits. For, although Mr. Trimmer, Mr. Godwin-Austen, Mr. Prestwich, and many other good geologists were at work long before this period, it was the systematic exploration of the Brixham cave, near Torquay (commenced in 1858), which first excited public attention to this interesting branch of geological inquiry, and set in motion similar explorations in France, Spain, Belgium, Italy, Malta, and elsewhere. Added to this, we became aware of those remarkable discoveries made by Prof. Keller and others of ancient Lake-habitations in Switzerland, somewhat resembling the Crannoges of the Irish Lakes (now mostly buried in peat-bogs, which have filled up these ancient fresh waters).

At the same time, our countryman, Mr. Henry Christy (then fresh from his Mexican travels), brought home to us not only the contents of the French caves, but also those of the Danish peat-mosses and refuse-heaps, thus adding new interest to the investigation of pre-historic man.

Nor have these varied materials been allowed to remain as idle curiosities in our Museums, to be objects of marvel or conjecture; on the contrary, they have been subjected to the most severe investigation by the best and ablest among our archæologists and geologists, and, like the vision described by the prophet Ezekiel (xxxvii.), we have seen the dry and mouldering remains of these ancient inhabitants of our island arise; we have seen the animals they followed in the chase, the weapons which they used, the ornaments they wore, and have even learned a good deal concerning the rude arts they practised. Nor is this all we have gained, for we can now compare each fresh discovery with such a series of recorded precedents, spread over such wide areas of explored country, that we can refer each find to one or other of a series of stages representing periods in the history of these ancient races, which, although not reducible to years, or even centuries, yet are capable of being dealt with in chronological sequence, just as the earlier deposits have been arranged by geologists long since.

The evidences of the remote antiquity of man are derived from various sources:—

1. The ancient quaternary river-gravel deposits.
2. The ossiferous caverns and rock shelters.
3. The shell-mounds or refuse heaps of Denmark, the Orkneys, the Welsh coast, etc., etc.
4. The Danish peat-mosses.
5. The Irish lakes and peat-bogs (crannoges).
6. The Swiss pile-works, or *Pfahlbauten*.

1. The first of these is, undoubtedly, of the most ancient character; but is also (as might naturally be expected) of the most meagre and restricted kind, chiefly consisting of flint implements of rude and simple form, and with but little variety of pattern. No authentic instance of human remains associated with these flint weapons is recorded; but, after the most careful investigation of these deposits

by Messrs. Prestwich, Evans, Falconer, and a number of other undoubted authorities, whose judgment may well be relied upon, the following conclusions were arrived at:—1st. That the flint implements are the result of design, and the work of man. 2ndly. That they are found in beds of gravel, sand, and clay, which have never been artifically disturbed. 3rdly. That they occur associated with the remains of land, freshwater, and marine testacea, of species now living, and most of them still common in the same neighbourhood, and also with the remains of various mammalia, a few of the species now living, but more of extinct forms. 4thly. That the period at which their entombment took place was *subsequent* to the Boulder-clay period, and to that extent Post-glacial; and also that it was among the latest in geological time—one apparently immediately anterior to the surface assuming its present form, so far as it regards some of the minor features.[1]

It is hardly needful to point out to you the regions included in this first division. The valley of the Waveney at Hoxne, Suffolk, where flint implements were found in the year 1800 by Mr. Frere. Archæologia for 1800, vol. xiii., p. 206.) The Ouse at Bedford, where Mr. Jas. Wyatt has found flint implements and remains of Elephant, Rhinoceros, Hippopotamus, etc. The Thames-valley high level gravel, where, in an excavation in Gray's Inn-lane, London, a flint weapon associated with the skeleton of an Elephant, was found so long ago as 1715; at Fisherton, near Salisbury; in the Trent, not far from Nottingham; in the Vale of Pickering, the Somme, the Seine, the Rhine, the Val' d' Arno, and many other localities.

2. The ossiferous caverns and rock-shelters have long been known, but not systematically explored until ten years since. Their contents, as might have been expected, are more rich and varied, and they have given us a greater insight into the state of civilization of their ancient occupants than almost any other. The British localities are in Devon and Somerset, near Torquay and Brixham, and in the Mendip Hills; the promontory of Gower in South Wales, where eight caves have been carefully explored by Colonel Wood and the late Dr. Falconer; the Coygan Cave, near Laugharne, Carmarthenshire, partially explored by Mr. Henry Hicks, of St. David's. (See GEOL. MAG., vol. IV., page 307, 1867.) The historical cave of Kirkdale, rendered famous by Dr. Buckland's researches. The Caves of Liege and of the Valley of the Lesse in Belgium; of the Vezere, the Dordogne, and the Aveyron in France, explored by Schmerling, Dupont, Lartet and Christy, the Vicomte de Lastic, the Comte de Vibray, and many others. Rich as is the fauna revealed by our English Caves, they cannot be compared for one instant as regards the human remains and works of art which the French Caves have made known to us, I say, advisedly, *works of art*, for we have now ample materials in this country even to show the wonderful ingenuity and skill displayed by the ancient Aquitanians in the fabrication of needles, weapons of the chase, both in wood and stone, swords made of reindeer horn, ornaments in the same material; and, lastly, in depicting the animals they knew living around them.[2]

[1] Falconer, Palæontological Memoirs, 1868. Vol. II. p. 598.

[2] Those interested in these researches, who have not yet personally inspected

The time forbids me to enter upon an account of the Shell-mounds and Danish Peat Mosses; nor of the Irish Peat-bogs and Swiss Pile-works, each of which would form a chapter by itself. On the contrary, I shall, by your permission, occupy your attention with a brief account of the fauna of the Pre-historic period generally, as revealed to us in the various superficial deposits included in what is now generally termed the Quaternary epoch.

In the accompanying Table I have endeavoured to show the species of animals found in association with early man, as evidenced by his weapons in one set of deposits, and by his osseous remains and handiwork in another. I have also introduced certain other species (those whose names are enclosed in square brackets) whose remains are not found with man, but in a somewhat older set of deposits, containing, however, some of the animals common to the Pre-historic epoch. Those names of species *not enclosed in square brackets*, are again divisible into—I. Animals known to man, but now extinct. II. Animals whose geographical distribution has been changed. III. Animals which have been exterminated by man; and, IV. Animals still indigenous to Britain and the neighbouring continent.

TABLE OF ANIMALS CHARACTERISTIC OF THE PLIOCENE AND QUATERNARY DEPOSITS OF BRITAIN, FRANCE, AND BELGIUM.

Castor *Europæus*, Owen	...	...	K		*Ovis aries*, Linn.	...	...	...	L
,, [*Trogontherium*, Fischer]	X				*Cervus elaphus*, Linn.	...	...	...	L
Mus *musculus*, Owen	...	...	...	L	,, *capreolus*, Linn.	...	...	...	L
Arvicola *amphibia*, Owen	...	...	...	L	,, *tarandus*, Linn.	...	M		
,, *agrestis*, Fleming	...	...	...	L	,, [*Sedgwickii*, Gunn]	X			
,, *pratensis*, Owen	...	...	...	L	,, [*Brownii*, Dawk.]	X			
Spermophilus *citillus*, Linn.	...	M			,, *dama*, Linn.	...	...	...	L
,, *erythrogenoides*, Falc.	X				*Alces malchis*, Linn.	..	M		
Lagomys *spelæus*, Owen	X				*Megaceros hibernicus*, Owen	X			
Lepus *timidus*, Linn.	...	...	...	L	*Machairodus latidens*, Owen	X			
,, *cuniculus*, Linn.	...	...	...	L	*Felis spelæa*, Goldf.	X	M[2]		
Lemmus *lemmus*, Linn.	...	M			,, *antiqua (?)*	X			
Elephas *primigenius*, Blum.	X				,, *catus*, Owen	...	...	...	L
,, *antiquus*, Falconer	X				*Hyæna spelæa*, Goldf.	X	M[3]		
,, [*meridionalis*, Nesti.]	X				*Canis lupus*, Linn.	...	M	K[4]	
Rhinoceros *tichorhinus*, Cuv.	X				,, *vulpes*, Briss.	...	...	...	L
,, *leptorhinus*, Owen	X				*Lutra vulgaris*, Owen	...	...	...	L
,, *megarhinus*, Christol	X				*Mustela martes*, Ray	...	...	...	L
,, [*Etruscus*, Falconer]	X				,, *putorius*, Linn.	...	...	...	L
Equus *caballus*, Linn.	..	...	...	L	,, *erminea*, Linn.	...	M		
Sus *scrofa, ferox*, Linn.	...	M	K[1]		*Meles taxus*, Owen	...	...	...	L
Hippopotamus *major*, Nesti	X				*Gulo luscus*, Linn.	...	M		
Bison *priscus*, Bojanus	...	...	K		*Ursus spelæus*, Blumenbach	X			
Bos *primigenius*, Boj.	X				,, *arctos*, Linn.	..	M		
,, *longifrons*, Owen	...	...	...	L	*Talpa europæa*, Schmerling	...	...	...	L
Ovibos *moschatus*, Pallas	...	M			*Sorex vulgaris*, Owen	...	...	...	L
Capra *hircus*, Linn.	...	...	...	L	,, *moschatus*, Linn.	...	...	...	L
,, *ægagrus*, Gmel.	...	...	...	L	*Saiga tarbarica*, Pallas	...	M		

X = Extinct. M = Migrated. K = Killed. L = Living.

rich collection of Pre-historic remains, so admirably arranged and displayed in the Ethnological department of the British Museum, and the Christy Collection (exhibited on Fridays,—admission by ticket, obtainable gratis any day at the British Museum), under the able direction of A. W. Franks, Esq., F.R.S., F.S.A., F.G.S.,—should take the first occasion to do so, and they will find themselves well repaid by seeing probably the best collection extant of works of early and savage man from all countries.

[1] The wild boar *Sus scrofa ferox* has been killed off in England, but is still found in France and elsewhere on the continent.

[2] *F. spelæa* is extinct, but if considered equivalent to *F. leo* it has *migrated*.

[3] *Hyæna spelæa* is extinct, but if considered to be the same as *Hyæna crocuta*, it has *migrated*.

[4] Killed off in Britain.

Of the names in brackets I will not say much, merely observing that the Forest-bed of the Norfolk Coast has yielded a most wonderful series of Pre-glacial forms, associated with many which lived on into the Post-glacial period, and were known to man.

The most remarkable, perhaps, are (1) the gigantic Beaver, *Castor Trogontherium,* which occurs in widely-separated localities, viz., the Norfolk Forest Bed, and in a sandy deposit on the borders of the sea of Azof. Dr. Schmerling also found its remains in the Caves of Liege. Another gigantic Beaver has lately been found in America, the *Castoroides Ohioensis,* Fost. (2.) A remarkable form of deer, *Cervus Sedgwickii,* which occurs in the Forest-bed, and is nearly allied to *Cervus dicranios* of the Italian Pliocene. (3.) Another species of deer, closely allied to the Fallow Deer, the *Cervus Brownii,* lately described by Mr. Boyd-Dawkins, now quite extinct, from the Pliocene deposit of Clacton, Essex. See Quart. Journ. Geol. Soc. 1868. Vol. xxiv., p. 511. Pl. xvii. and xviii. (4.) The *Elephas meridionalis,* common to the Forest-bed and the Val' d'Arno, in Italy—a form somewhat more like the African than the Indian species as regards the arrangement of the enamel-layers of its molar teeth. 5. The *Rhinoceros etruscus,* found in the Norfolk Forest-bed, and also in the Val' d'Arno.

Animals known to man, but now extinct.—I have always felt some hesitation in accepting the statement that the *Machairodus* existed down to the Pre-historic period; but its discovery by the late Rev. J. McEnery, in Kent's Hole, in 1825 (published by E. Vivian, Esq., 1859), having been confirmed by Mr. Pengelly, F.R.S., in 1867, (see British Association Reports, Dundee, 1867), there seems reason to believe that it may have lived on till the commencement of this period. Certainly this was the most remarkable of the contemporaries of early man, and probably his most formidable rival in the hunting-grounds of Western Europe. The sabre-toothed lion has only been met with in this one cave in England, but it also occurs in the district of Auvergne, in France, and in the Val' d' Arno, in Italy. The largest species of this carnivore is found at Buenos Ayres, on the La Plata.

Of the species of Bear which occur in the fossil state, two at least, the *Ursus spelæus* of our caves, and the *Ursus priscus* of the Gailenreuth cavern, have been considered as well-marked extinct forms. The Bears are, perhaps, of all the carnivora, the most difficult to determine, on account of their mixed diet and their consequent variable dentition: they have been as widely distributed in times past, as in our own.[1]

Of the one extinct species of the Cervine family—the *Megaceros Hibernicus,* or Gigantic Irish Deer, deserves especial notice. This splendid animal was not by any means confined to Ireland, although it is quite possible that it may have lingered on in that country after it had been exterminated in Britain. There is a fine specimen of the entire skeleton of this animal in the British Museum. The size of this deer is immense, even when compared with our largest living species; when erect, the topmost prong of his antlers was more than ten feet from the ground, and in breadth across they measured more than nine feet. The bones of the Irish deer occur in the beds of marl which underlie the peat-bogs, and they are generally very perfect, being stained more or less deeply by tannin or iron, and sometimes partially incrusted by pale blue phosphate of iron. Even the marrow of the bones occasionally remains in the state of a fatty substance, which will burn with a clear lambent flame. Groups of skeletons have been found crowded together in a small space, in a peat moss, with the skulls elevated and the antlers thrown back upon the shoulders, as if a herd of deer had fled for shelter or been driven into a morass and perished on the spot. Besides the numerous remains of this deer found in Ireland, its bones and horns have been obtained from Kent's Hole, the Forest-bed on the Norfolk coast, Kirkdale Cave, and numerous other localities.

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[1] The teeth of pigs, dogs, and bears, are all subject to considerable variation, owing to their mixed diet.

Of the Oxen, the most ancient is the *Bos primigenius*. Professor Owen maintains the opinion that this gigantic ox (the *Urus* of Cæsar, which dwelt in the great Hercynian forest), was *never* tamed by the Britons or Romans, but was only an object of the chase. Its remains are alike common to the caves, the river-valley deposits, and the peat-bogs.

A grand head, and entire horn-cores, with a large proportion of the skeleton of *Bos primigenius*, was obtained from beneath the peat near Cambridge. The peat had grown into and filled the cavities of the skull and all the bones. On the removal of the peat from the frontal bones, *a stone celt* was disclosed, broken off short *in the forehead*, which it had pierced, and had been apparently left there as useless by the hunter, to whose skill the mighty beast had fallen. The specimen is now in the Woodwardian Museum, Cambridge.

I was present at the disinterment of two magnificent pairs of horn-cores at Ilford, in the Brick-earth of the Thames valley, only a short time since. This species is readily distinguished from the Bison by the large size, length, and curvature of the horn-cores and by the form of the skull. *Bos primigenius* is found both in deposits with human remains, and in those anterior to man's era.

Of the *Elephants*, two forms, long confounded together, are now known to have been contemporary with man in Europe, viz., 1. *Elephas antiquus*, Falc., and 2. *Elephas primigenius*, Blum.

The former of these (*E. antiquus*) was long considered as identical with *E. primigenius*, but Dr. Falconer has shown that by the characters of the molar teeth they may be distinguished. 1st. By the narrowness of the tooth in proportion to its length and height. 2nd. By the great height of the plates, being twice that of the width of the crown. 3rd. Mesial rhomboidal expansion of disks of wear. 4th. Great crimping of the enamel plates.

The tusks of *E. antiquus* are nearly straight. The remains of this species are almost as widely distributed in our bone-caverns and River-valley gravels and Brick-earths, as are those of *E. primigenius*. No fewer than 2,000 elephants' grinders are recorded by my father, the late Mr. Samuel Woodward, as ascertained to have been dredged during a period of thirteen years upon the oyster-bed off Hasboro', on the Norfolk coast; "by far the largest number of these," says Dr. Falconer, "belong to *Elephas antiquus*."

Elephas primigenius (the "Mammoth," properly so called,) possesses unusual interest in connection with early man. Not only because it is one of those forms which, there is reason to believe, extended back into Pre-glacial times; but also because it is apparently brought so near our own day by the discoveries of entire bodies of this remarkable beast embedded in the frozen soil and ice of the great rivers of Siberia and in Behring's Straits; no fewer than nine of which are on record. Its range in geographical area was equally great. It has been found in Ireland, Britain, through Europe, from the extreme north to the hills of Rome, and from France to the Ural Mountains, thence across Siberia into N. America, and southward to the Ohio, where its remains occur with those of the *Mastodon* in Big-bone-lick, Kentucky.

In October, 1864, I had the pleasure to visit Ilford, in Essex, and there see and examine the only existing cranium of *Elephas primigenius* with the tusk attached which has ever been obtained and preserved in this country. It is entirely owing to the skill and great practical judgment of Mr. W. Davies, of the Geological Department of the British Museum, that this fine fossil was ever raised from its matrix to adorn our National Museum.[1] No doubt hundreds of these remains have turned up in the valley of the Thames alone, but never before was the requisite skill brought to bear upon so unwieldy and friable a relic. The right tusk, which was found detached from the skull, measured ten feet ten inches, including the portion which in the left side is enclosed within the alveolus. From the top of the cranium to the end of the socket of the tusk is four feet. The circumference of the tusk, one foot from the socket, is twenty-six inches.

The three species of *Rhinoceros* are all extinct. Of the three—(1) *R. megarhinus*, or the great slender-limbed Rhinoceros, with largely-developed nasals, appears to be characteristic of the Norfolk Forest-bed and Grays Thurrock. It also occurs in France, associated with the *Mastodon brevirostris*, and in Italy with the *Mastodon arvernensis*. (2) *R. tichorhinus* and (3) *R. leptorhinus* are the two species common to the ossiferous deposits of our caverns, and they also are found together in the Brick-earth of Ilford. A unique skull (the only one known) of *Rhinoceros leptorhinus*, was obtained from the same brick-field at Ilford which yielded the Mammoth skull. We are indebted also to Mr. Davies for the preservation of this most valuable relic. All these Rhinoceri were *bicorn*, and resembled the Sumatran species. Like the Mammoth, the Rhinoceri had an enormously extended range in Pre-historic times. One of the earliest remains found in Russian Siberia, imbedded in ice, was an almost entire example of the great woolly *R. tichorhinus*, found in 1772 by Pallas, on the banks of a tributary of the Lena, lat. 64 degrees.

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[1] See GEOLOGICAL MAGAZINE, 1868, Vol. V., p. 540, Pl. XXII. and XXIII.

This carcass emitted an odour like putrid flesh; part of the skin was still covered with short, crisp wool, with black and grey hairs. The head and foot are preserved at St. Petersburg, in the Royal Museum.

Hippopotamus major.—As might be expected, the remains of the *Hippopotamus* are more frequently found in river-deposits than in caves. Yet this remark does not hold good in all cases. Remains have been found in one of the Gower Caves (Raven's Cliff), Durdham Down Caves, in Kent's Hole near Torquay, Kirkdale, and other localities, but in the Grottoes of San Ciro and Maccagnone, in Sicily, the Hippopotamus remains formed by far the greater bulk. Many ship-loads of these interesting relics were quarried and sent to Marseilles and England to be used in sugar-refining! Professor Ferrara, who examined the remains, stated that the great mass belonged to two species of *Hippopotamus.* Those collected by Dr. Falconer are preserved in the British Museum, and identified with *H. major and H. Pentlandi.* It is abundantly distributed through our River-valley, gravel and Brick-earth deposits, and occurs from Yorkshire southwards through England, France, Belgium, Spain, Italy, etc.

From observations of the habits of the living animal (*H. amphibius*) in South Africa, we learn that, where undisturbed, it frequents with equal pleasure the coast as it does the rivers, and that north of Port Natal they not only swarm in the rivers but upon the sea-shore, retreating to the sea when disturbed or attacked. Such evidence as this enables us to understand the presence, in Pre-historic times, of the *Hippopotamus* in Britain during the summer, even after this country had been isolated from the Continent, although this seems not to have been the case, until nearly the close of the Quaternary period.

A species of Marmot (the *Sphermophilus erythrogenoides* of Falconer), and another Rodent (*Lagomys spelæus*), a species of tailless hare, completes the list of extinct species contemporaneous with man. For, incredible as it may seem, it appears that after a careful investigation of the remains of *Felis spelæa,* the Cave-lion, Messrs. Boyd Dawkins and Sanford have concluded that it cannot be differentiated in *any way* whatever from the existing lion of Africa. And again that *Hyæna spelæa* is only a variety of *H. crocuta,* the great spotted Hyæna of S. Africa.

We now pass therefore to *Animals whose geographical distribution* has been changed. These we can analyze more fully than the extinct forms before enumerated; and they arrange themselves naturally into two divisions—those which have migrated north, and those which have migrated south.

The first division, as you will have anticipated, is by far the largest of the two, including nine species. The second consists of two only (the Cave-lion and Cave-hyæna already referred to).

Spermophilus citillus — "the pouched Marmot" is the first. Its remains have been found at Fisherton, the Mendip Caves, and elsewhere in England, and also in the Liege Caverns. It is still met with in northern and central Europe, near the snow-line.

The Lemming (also found at Fisherton, near Salisbury) is now represented in Lapland, Norway, Greenland, Siberia, and Arctic North America. Its migratory and gregarious habits have been ably described by Richardson and others.

The *Ovibos moschatus*—"Musk-ox," or "musk sheep," possesses peculiar interest, as one of those generalized species still left us, which we were long at a loss where to place with certainty, whether with the Oxen or the Sheep. M. Lartet has shown, however, reason for placing it with the *Ovidæ* and *Capridæ*. The gravel of the Avon, the river-gravel near Maidenhead, and Green Street Green, in Kent, and the Crayford brick-pits, in the valley of the Thames, have all yielded examples of this animal. It has also been detected by M. Lartet in France. In Siberia its remains occur in the frozen mud of the great rivers, which yield the bodies of the Mammoth, along the whole line of the shores of the Polar Sea. Its living habitat is now the barren, treeless wastes of the high northern latitudes of North America, and our Arctic voyagers have traced it and lived upon it so lately as 1856. Captain (now Sir Leopold) M'Clintock gives the following statistics of the Musk-ox in a paper read before the Royal Dublin Society, 25th January, 1857:—Musk-oxen on Melville Island, April 4 and May 13, saw 59 (shot two); third visit, July 1 to 19, saw 30 (shot two); Prince Patrick's Island, May 14 and June 26, saw 5 (shot three)—total seen, 94; number shot, seven. They were so unused to man's presence that, when one of a herd was shot, it was often difficult to induce the rest of the party to move off, so as to allow M'Clintock and his men to take possession of their fallen comrade. We cannot help contrasting this brave and noble sailor's conduct with that of the Laird of Lamont. M'Clintock observes, "We never killed more than we absolutely needed." Mr. Lamont, on the contrary, gives a list of walruses and other victims "*shot for pastime*," and left to render still more desolate with their decaying carcases these northern seas.

4. The "Saiga Antelope" deserves a word. It has lately been determined as occurring in the caves of France, with the reindeer, etc. An antelope is recorded as being found fossil, together with several species of deer, beaver, wild boar, etc., in shell-marl beneath peat, near Newbury, in Berkshire, by Dr. J. Collet, F.R.S., in 1757.—(Phil. Trans.) May not this also have been the Saiga antelope? It is now found to inhabit the eastern slopes of the Ural Mountains, and the shores of the Sea of Azof. On a small island a number were found living, so tame as to be undismayed at a discharge of fire-arms. It is to be seen alive in the Zoological Gardens. It is the only tapir-snouted antelope known.

5. The brown bear, *Ursus arctos*, occurs both in Britain and Ireland. Undoubted remains from Longford, in Ireland, and Manea Fen, Cambridgeshire, are preserved in the British Museum. It still lives in Russia. So lately as A.D. 1057 bears were natives of

Scotland and Wales, and reckoned among the beasts of the chase, equal to the hare or the boar (Ray, Syn. Quad. p. 214).

6. *Gulo luscus*—the "Wolverine," or "Glutton"—was once a native of this country, as its remains testify from the caverns of Banwell, Bleadon, and Gower. It is still common in Siberia and North America, and is the pest of the fur-hunters of those countries.

7. The "Ermine," *Mustela erminea*, is another of the Weasel tribe, now gone North-east, and over the Ural chain into Siberia.

8. The "Elk," *Alces malchis*, has been met with in Scotland, at Chirdon Burn, beneath peat, in a similar deposit as the *Megaceros* in Ireland. A lower jaw also has been obtained from Llandebie Cave, in South Wales. It is the true Elk of Norway, or Moose-deer of the Canadians.

9. If we take into consideration the relative importance of the various animals to man in his hunter state, the whole list is probably surpassed by the Reindeer (*Cervus tarandus*). Not only do we find its remains in greater profusion than that of any other animal in those caves in which man undoubtedly resided, but his weapons were for the most part fabricated from its horns, bones, and sinews; and doubtless, his clothes were composed of its skin. The later investigations of Mr. Pengelly, at Torquay, have led to the discovery of similar barbed javelins of Reindeer horn to those of the French Caves. That fewer cut antlers have been found in England than in France, may be due to the more savage condition of the early Britons; but it cannot be attributed to lack of the reindeer. In Bosooe's Den, Gower, South Wales, more than 1,000 antlers have been obtained by Colonel Wood; indeed, their remains are almost co-extensive with the cavern and river-valley and peat-deposits. It is reasonable to suppose that the reindeer may have retained a footing in Scotland even long after the Roman occupation of Britain; but it must have yielded, if living there, not only before the pursuit of the chase by man, but also before the overpowering influence of the red-deer, *Cervus elaphus*, and still more to the great change in physicial conditions which effected our climate. That the reindeer could continue to live for long in Britain after its isolation from France, seems unlikely, for the migratory instincts were as strong in the race then as at the present day. The only change produced has been to modify the area which the migration formerly extended over. Instead of migrating southward in winter, from Norway and Denmark into France and Britain, they are not only pressed northward by the great tide of human beings which has occupied their former territory, but also by the change in the thermometer. Vast as was the range of the reindeer in past times, we see how enormous is its kingdom in our own day. Through Northern Europe, Asia, and America, it occupies the area from the edge of the woods to the farthest northern latitude, crossing the frozen sea fearlessly in vast herds from land to land. Sir Leopold M'Clintock mentions seeing, on Melville Island, in April and May, on two visits, 29 head of reindeer, two of which he shot. In July, on two visits, he saw 74, and again shot one. On Prince Patrick's

Island, in May and June, he saw eight, and shot five. On Emerald Island, in June, 13 head; being a total of 124 head seen in these three far northern islands, between 76° and 77° North lat.

When migrating in Siberia, says the Russian Admiral von Wrangel, the migrating body may consist of many thousand head of deer, and though they are divided into herds of some 200 or 300 each, yet they always keep so near as to form only one immense mass, sometimes 60 miles in length. In crossing the rivers they all follow the same route. They select a place where a dry valley leads down to the stream on one side and a flat sandy shore facilitates landing on the other. As each separate herd approaches the river, the deer draw more closely together, and the largest and strongest buck takes the lead. He advances, closely followed by a few of the others, with head erect, and apparently intent on examining the locality; having satisfied himself that all is right, he enters the river, the rest of the herd crowd in after him, and in a few minutes the surface is covered with them. It is doubtless due to casualties in these migrations that we owe some, if not all, of our reindeer bones in river-valley deposits. Detached antlers may easily be explained where they occur in quantities (as in the peninsula of Gower, in South Wales) by the annual shedding of the horns; but most of those from the Caves have a part of the skull attached to the burr of the horn. This is so in more than 50 from the Cave of Bruniquel, which have passed through my hands.

In many of the Caverns of Central and Southern France we have abundant evidence that the wild Horse was largely eaten by the Cave-dwellers, and that its bones formed an important article for the fabrication of many of their weapons of the chase, and also for their needles. Remains of Horse are abundant in the Bruniquel Cave.

Of the animals now living, but become extinct in some regions, the Beaver—*Castor Europæus* (or *Castor fiber?* of Canada) from being killed by man is, probably, quite extinct in Europe. Only one refuge seems left to it by any chance, and that is the mouths of the Danube in the Euxine Sea, where its fossil congener is found. It was formerly abundant in our Welsh rivers, even at a late date, comparatively speaking. It was scarce in the 9th century, in the 12th it was only found in one river in Wales, and another in Scotland. There can be no doubt the Beaver was killed off the face of the land for the sake of his fur coat. His remains are abundant in the Cambridgeshire fens, and he did his best to divert the rivers and destroy the land for his own pleasure, but like other selfish pleasure-seekers, his would-be pools became peat, and in it are embedded the bones of the curious, ingenious, but destructive rodent, who aided the mischief.

In a single night, not long since, the Beaver at the Zoological Gardens diverted all the water of his pond, by the introduction of mud into his tank, and sent several dozen gallons of very dirty water over the gravel walk. He wanted to make a dam—failing which he made a mess!

The Lithuanian Bison—preserved by Imperial ukase of his Majesty the Emperor of all the Russias—once roamed the Prairies of Europe as his congener now does those of America. But he couldn't be tamed and made to plough like *B. longifrons* and *B. taurus*, and so the natives killed him off, and he would be soon extinct, like his old rival *primigenius*, but for the Emperor.

The wild boar and the wolf were only killed yesterday. The former (*Sus scrofa ferox*) abounded in Henry II.'s time, whilst the latter (*Canis lupus*) survived in Ireland till 1710. Blood-money was put upon his head as upon the tiger in India at the present day. The present foxes are mostly re-introduced, and owe their existence to *Protection*. The Wild-cat, Badger, Marten, Pole-cat, and even the Otter, are becoming rare as British species. These all owe their extinction to man. The Red Deer, Roebuck, and Fallow Deer only exist by means of protective legislation.

Of birds, the Capercailzie, or "Cock of the Wood," is extinct with us, though still occurring in Norway. The two Bustards (*Otis tetrax*, the little bustard, *Otis tarda*, the great bustard), are both exterminated. Formerly they could live on the wastes of West Norfolk and Wiltshire. The great Crested Grebe—*Podiceps cristatus*, the great Bittern—*Botaurus stellaris*, and the freckled Heron, *Botaurus lentiginosa*, once rejoiced in the Fens of Cambridgeshire and Dorset. The fen-lands are gradually becoming drained and cultivated, and these birds are mostly dead. The White Spoon Bill (*Platalea leucorodia*), the White Stork (*Cicornia alba*), and the little Glossy Ibis (*Falcinella igneus*), once were summer visitants of ours, now they come no more. The Herons are fast dying out, and require "Protection" like the Grouse and Partridges. The Golden Eagle and numbers of *Falconidæ* and lesser birds of prey have also been lost.

Among the interesting associations of the past, to the Naturalist, will always be counted the Great Auk, once an inhabitant of the Orkneys and the shores of Denmark, found in the Kitchen-Middens of both, and also in the Indian Shell-heaps of New England. The last of his race is believed to have perished so lately as 1846. And no wonder! for the poor bird could not fly, so the old Danish sailors used to lay a plank from the ship to the shore, and compel their unfortunate victims to "Walk the plank," "single file," and fall into the ship's waist, where they were killed and eaten. One skipper boasted that he had brought off thirty boat-loads in an hour. Once this bird covered the shores of the north—Labrador, Nova Scotia, Newfoundland, Greenland, Iceland. Now we look in vain for a single one.

The Dutch sailors were just as merciless to the Dodo in the Mauritius, and the Maories to the *Dinornis* and the Great Rail in New Zealand, and the people of Madagascar to the *Epyornis*.

Changes (insensibly it may be, yet, nevertheless, surely) are going on year by year around us. We see but little in the lifetime of an individual; but the retrospect of a century shows vast changes in our condition as a race for example.

Each step in retrogression will appear more and more marked.

Go back a century, where are our railroads, our telegraphs, our steam-vessels, our rifled cannon?

Still further, and we have not our colonies, and the world is only half-known.

Further still, and we have not learned Christianity, and worship idols; we are ignorant, superstitious, and cruel. Still further, and behold the savage depending on the chase, trusting to his instincts to supply his wants. And now to ignorance, superstition, and cruelty, he has added dirt; for he is not at all particular about his abode, provided he be dry, warm, and his hunger appeased. His life was not one constant state of alarm—indeed, he was happier in this respect than his black representative of to-day. The Negro lives in a stockaded village in terror. Why? Because, although slavery is at an end in America, it is not quite at an end elsewhere; and the cruel passions that ardent spirits and vice have engendered in the slave-trading population of the coast, seek gratification in acts of cruelty and violence, often of a far more terrible nature than any pre-historic savage would have invented.

There can be little doubt that the designation, "*the noble savage,*" belongs almost entirely to the past. If we except the New Zealanders, the savage races of to-day are probably, as a whole, less civilised than the men of the French caves and the Swiss pile-works. Witness the Andaman Islander, the Terra del Fuegian, and the Australian native.

The old Cave-men represented the population of the less-civilised portions of the globe, as these aborigines do now in our own day; for there never was a time in the Earth's past history when a uniform condition of things obtained, unless in pre-Silurian epochs.

Faunas slowly but constantly migrate, a part becoming extinct, some races improving, some remaining persistent.

Peoples migrate—some are exterminated (witness the native races dying out before the over-mastering effects of a too-advanced white civilization)—the remainder in part improve (being, as individuals, capable of improvement) those which remain unchanged, do so because they are not exposed to the elements of change.

There is little doubt that man has been upon the earth long enough to have witnessed many physical changes, and even considerable modifications in the climate of Europe. We can the more readily accept this, because from the brief portion of the record of our race embraced in the historic period, we know that many changes in physical conditions have come to pass, and some, indeed, are even now taking place around us.

The duration of the Pre-historic period, as compared with the historic, may best be conceived when it is borne in mind that very old countries like India, whose history goes back further into the past than any other, have still a lost history apparently far longer than that handed down to us, evidenced by Megalithic and other monuments of unknown antiquity; and again, beyond that, Prof. Blanford; Messrs. King, Foote, Wynne, and other of the Geological Surveyors, have obtained evidence of a still earlier and barbarous race, whose only relics are their stone-implements, fashioned of the Neolithic and Palæolithic types, like those of the aborigines of Gaul and Britain.

How many thousands of years must have been occupied in the gradual distribution of these earliest representatives of our race, whose implements have been found in almost every portion of the globe (formed in the same simple yet persistent types), can only be realized by the geologist who has learnt that many prior races of beings lived and spread out over the whole globe, and have been as gradually exterminated and re-placed with other races, who have followed in successive eons, differing in form, yet modelled on types analogous to those now existing.

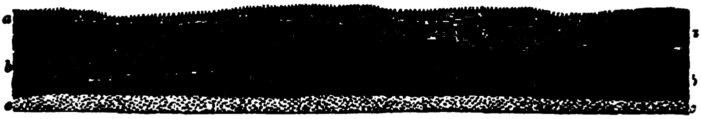
IV.—On some Raised Shell-beds on the Coast of Lancashire.

By George Maw, F.G.S., etc.

SOME portions of the Lancashire coast in the Furness district give evidence of considerable changes of level since the first elevation of the Glacial deposits. The Boulder-clay formation of Cumberland and Lancashire exhibits a well-marked subdivision into a lower tough blue Boulder-clay, overlain, apparently on its eroded surface, by a redder silty clay of more variable composition. The same subdivision holds good along the coast of N. Wales; but I cannot satisfy myself that it can be definitely correlated with the succession of the Glacial series of the Norfolk and Suffolk coasts, or that the lower tough blue Clay can be traced inland much above high-water level.

The superposition of these two clays is well exhibited on the coast, a little to the south of Workington, where (Fig. 1), the blue Clay (*b b*) from 25 to 30 feet thick, containing many transported boulders of considerable size is overlain by the reddish clay (*a a*), containing fewer blocks.

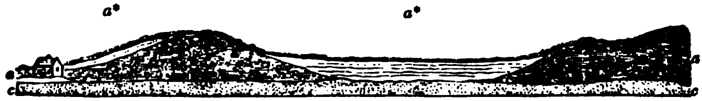
FIG. 1.—BOULDER-CLAY CLIFF SOUTH OF WORKINGTON, CUMBERLAND.



c c. Sea-Beach high-water mark.

At Rampside, near Peel Harbour, Lancashire, isolated portions (*a*) of a reddish Boulder-clay, apparently identical with the Upper

FIG. 2.—BOULDER-CLAY OVERLYING SHELL-BEDS, RAMPSIDE, PEEL HARBOUR, CUMBERLAND.



c c Sea-Beach high-water mark.

Boulder-clay of the Workington section, rise up as low cliffs along the coast and contain a large proportion of granite and other transported boulders. Here the subjacent blue clay is not visible, but it probably occurs below the sea-level.

My attention has been drawn by Professor Harkness to the occurrence of extensive shell-beds (a°) at this point above high-water mark. In some places, for example, behind the cottage near the beach at Rampside, it is difficult to determine that they are distinct from the Boulder-clay deposit, but a little to the east it is apparent that they are superimposed on its eroded surface. The Boulder-clay (a) rising up in isolated masses, and the evenly stratified sand and shell beds (a°) lying between them. The shells *Ostrea, Mytilus, Cardium, Pecten, Littorina,* etc., are identical with those on the adjacent shore, and occur in profusion, unlike the shell-remains of any Glacial deposits. These beds may probably be of similar age, and represent the same elevation as the raised beaches occurring along the north and south Devon coasts, though from the absence of cohesion of the materials they have a different mineral aspect.

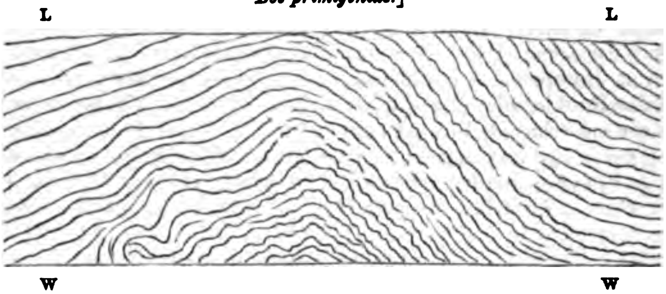
The series at Workington and Rampside appear to imply several distinct oscillations of level, possibly one at the interval between the deposit of the lower tough blue Boulder-clay and the Reddish Clay, for an eroded surface seems to separate them. 2nd. Emergence after the deposit of the Red Clay, with an irregular erosion of its surface. 3rd. Re-submergence during the deposit of the Post-Glacial shell beds, and lastly a rise of the coast of at least ten or fifteen feet to place the shell beds above high-water-mark.

V.—Additional Note on the Discovery of *Bos Primigenius* in the Lower Boulder-clay, at Crofthead, near Glasgow.

By James Geikie, Geological Survey of Scotland.

In my former note on the discovery of *Bos primigenius* in the Lower Boulder-clay, I stated that there was some "slight twisting and confusion" of the stratified deposits below the superincumbent Boulder-clay, which might have been caused by the pressure of glacier-ice. As the crumpling of sand, clay, and gravel, below Till, is by no means uncommon, and has frequently been described, I did not think it worth while at the time to give any drawing of the contortions exposed in the new railway cutting. But some geological friends having asked me about the character of these crumplings, it may not be out of place if I now add a few particulars. When my former note was written the disturbed portions of the stratified deposits were not very well exposed, and consequently I did not in my communication lay much stress upon their occurrence, although I had little doubt as to their origin. Upon visiting the section some weeks later, however, I found the crumplings well displayed. In October last I saw them again, in company with my brother, Mr. A. Geikie. By that time the section had been still better developed, and the annexed sketch of a portion of the crumpled clays was made.

[Stratified Beds in the Lower Boulder-clay, from which were obtained the remains of *Bos primigenius.*]



Crumpled Clays in Railway Cutting near Crofthead, Renfrewshire, as seen on 22d Oct., 1868.
L. Level of Railway Cutting—the overlying Boulder-clay removed.
W. Level of course cut for water.

The drawing represents a thickness of about seven feet, but as the cutting did not go down to the underlying Till, the depth to which the crumpling extends could not be ascertained. These crumplings have not been confined to one portion of the section, for during the progress of the cutting they were exposed in several places, and were noted at the time by one of my colleagues and myself; but when I saw the cutting in October it was quite evident that since my last visit in July the navvies had not been idle. A large part of the stratified beds had been removed, and the twisted and confused areas first observed had disappeared. In one part, since demolished, we could distinctly see that the crumpling had been caused by pressure from above, for underneath the crumpled beds (which were confined to the top of the section), the clay and sand were quite undisturbed.

I have nothing material to add to the description of the stratified beds given in my former communication. The plant-remains, to which I referred, were only obtained after a careful search, and they were much too decayed for me to recognise them; but when I saw the section at a subsequent time there was a better exposure, the vegetable matter forming in places a dark peaty layer. I did not put this peaty matter under the microscope, but it appeared to be made up chiefly of grasses, and was just such a deposit as was likely to have accumulated in a lake.[1]

A further examination of the glacial striæ of the Cowdon Valley has convinced me that instead of *one* there are three sets. The common direction of the ice scratches in that neighbourhood is from about north to south; and the Lower Boulder-clay contains fragments of gneiss, mica schist, granite and other north country rocks. Even as far south as the valley of the Irvine, such wanderers from the Highlands may be detected. The prevailing movement of the ice, which deposited the Lower Boulder-clay of this region, must therefore have been from north to south; but in the Cowdon valley there is evidence of a movement in the opposite direction. The knob of trap-rock, against which the *Bos*-bearing beds have been deposited, is glaciated *down* (*i.e.* north-east), and not *up* the valley as stated in my note. An older and much fainter set of striæ (the direction of which is not apparent, but may either be up or down the valley) are nearly obliterated by the later set; while on the north side of the valley above the railway cutting, and quite close to Crofthead, the rocks are glaciated *up* the valley or towards the south-west. Similar appearances have been noted elsewhere, showing that the ice-streams, from the various centres of outflow sometimes prevailed the one against the other.

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[1] I understand that these plant-remains will shortly be described before the Natural History Society of Glasgow, by Mr. Mahony.

In concluding this short note it may be remarked that the intercalated deposits of sand, gravel, and clay, so commonly met with in the Lower Boulder-clay, are of much greater extent sometimes than is generally known. During the progress of the Geological Survey in Scotland we have collected many data bearing upon this point, which we expect to publish ere long. Meanwhile, it is to be hoped that local geologists will lose no opportunity of searching the intercalated beds of the Boulder-clay, for the discovery of *Bos primigenius* in this position renders it not improbable that there may be other mammalian remains waiting to be disinterred.

NOTICES OF MEMOIRS.

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I. PALÆONTOLOGICAL ADDRESS. By Dr. ALBERT GAUDRY.

[Faculté des Science. Cours annexe de Paléontologie. Leçon d'ouverture.—Extrait de la Revue des Cours Scientifiques. Paris, 1868.]

AFTER a few introductory remarks, Dr. Gaudry gives a brief sketch of the history of palæontology. The notions respecting fossil remains were very vague, until George Cuvier asserted that in order to arrive at a definite opinion on the subject, it was necessary to study living animals. From that time palæontology has steadily progressed. Between 1823 and 1867, so M. D'Archiac relates, 5,852 plates of fossils were published; — the figures sufficiently express the advance of the science. Cuvier was, above all others, the founder of Palæontological Science, and well may France be proud of him.

"The beings of geologic times," says Dr. Gaudry, "present a marvellous diversity, but more marvellous still is the unity which is concealed under this diversity."

In regard to the interesting question of the origin of species—does each species represent a production independent of that which has preceded or followed it? or were they descended from beings found in the more ancient geological epochs?—Dr. Gaudry's opinion may be surmised from his again asking "Is it not the history of a slow evolution which, harmonious in all its phases, has been going on since the first days of the world?"

"The hour for definitely deciding this question," he continues, "has not yet arrived, but we can, at least, work towards its solution." The founders of palæontology have paid attention to the differences rather than to the resemblances between fossils and living animals. Cuvier's design was to prove their distinctive character. Moreover, the older writers had not sufficient materials for studying the connecting links, which are now more and more apparent.

In the time of Cuvier, it was not known that there were fossil apes, whence have been descended the existing species; the intermediate forms between the dogs and the bears, between hyænas and civets, between the mastodons and the elephants, between horses and the other pachyderms, were not known at that time; and further, it was not known that there are certain transitions between reptiles and fishes, between fishes and crustacea.

Now we have the labours of Falconer and Cautley, of Lartet, Kaup, Leidy, Owen, Huxley, Hermann von Meyer, Agassiz, Deshayes, Barrande, Pictet, Davidson, Milne Edwards and Haime, Unger, Heer, de Saporta, and a host of others. We must not only admire their works, we must also profit by them. They have accumulated treasures so well that we begin to feel embarrassed by our riches.

Dr. Gaudry concludes with an outline of subjects to be embraced in his course of palæontological lectures for the year.

Commencing with the Lake-dwellings of Switzerland, and the Kitchen-middens of Denmark, he will take the formations in descending order, noticing the fauna and flora of each. "Among the molluscs," he remarks, "the Ammonitidæ, above all, will interest us by the numerous examples of evolution which they present, from the straight Baculite to the spiral Ammonite." And among the Palæozoic Cephalopods the transformations between the simple Aphragmites, Ascoceras, to the complicated Nautilus and Goniatites. "Finally," says the Doctor, "I shall say some words on the Eozoōn, that rudimentary animal, which, as its name indicates, marks the dawn of life. Arrived at the mysterious point of origins, I shall make some remarks on the evolution of beings, to make apparent the simplicity and beauty of the plan which has been followed by the Author of Nature.

II.—CONTRIBUTIONS TO THE GEOLOGY OF DEVONSHIRE.

1. THE SUBMERGED FOREST AND THE PEBBLE RIDGE OF BARNSTAPLE BAY.
2. THE HISTORY OF THE DISCOVERY OF FOSSIL FISH IN THE DEVONIAN ROCKS OF DEVON AND CORNWALL.
3. THE LITERATURE OF KENT'S CAVERN, TORQUAY, PRIOR TO 1859.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

[Reprinted from the Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art, 1868.]

1. THE Pebble Ridge is situated on the southern shore of Barnstaple Bay, in North Devon, where it forms a natural breakwater to protect an extensive, sandy, and grassy plain, but little, if at all, above the level of spring-tide high-water, and known as

Northam Burrows. "The pebbles, or boulders, vary from half an inch to a yard in mean diameter, the majority being about nine inches. The greater number of them are oblate spheroids, but occasionally prolate and nondescript forms present themselves." They are derived from the Carboniferous grit of the district, and without doubt came from the cliffs westward of the ridge,—between Northam Burrows and Hartland Point—the southern shore of the bay.

"Seaward from this ridge, the tidal strand at first consists of small pebbles, of which the great majority are also of grit, whilst a few are of flint. Beyond this, to the low-water-line, it is composed of fine sand, beneath, and frequently projecting through which, are large accumulations of tenacious blue clay and vegetable matter, containing roots, trunks, and branches of trees. The vegetable remains are known as 'The Submerged Forest of Barnstaple Bay.'" The clay is in some places six feet thick, and reposes on a bed composed of rounded and angular fragments of the grit of the district, which, with the exception of the angular pieces only, resembles in all respects the Pebble Ridge.

The present position of this Forest-bed may be hypothetically explained either by a subsidence of the country, or by the removal of some natural breakwater which formerly protected the Forest from the ravages of the sea. Mr. Pengelly shows that the former supposition is the only one with which the facts agree.

"That the entire country around Barnstaple Bay has undergone upheaval in times geographically recent, is established, beyond a question, by the fine Raised Beaches which fringe its coasts." It is obvious, then, that the Forest and the Raised Beach represent two distinct periods. Mr. Pengelly regards the Beach as the more ancient—that the elevation preceded the depression, and that during the Forest era the height of the Raised Beach above the sea-level was, at least, twice as great as it is at present.

He finishes by remarking "how utterly fallacious must be any conclusions based on the assumption that our country has stood still ever since the ancient beaches were first raised."

2. Until very recently but four specimens of fossil fish from the Devonian rocks of Devon and Cornwall were on record, and two of these were considered very doubtful. But now "the paucity is by no means so marked as was then believed; and this, not in consequence of the discovery of new specimens, but because certain fossils, formerly supposed to be sponges, have been found to be veritable ichthyolites." Mr. Pengelly's object is to give an historical statement of the discovery and examination of the fossils alluded to.

In his own collection he has upwards of three hundred fragments of Pteraspides from the Devonian rocks. "We have been taught to believe that the Devonian System and the Old Red Sandstone System are of the same age, One of the greatest difficulties in the way of the acceptance of this doctrine, was the fact that, whilst the Old Red Sandstones teemed with fossil fish, there were none in the

Devonian rocks. The shoal of Pteraspides now caught in Devon and Cornwall will go very far to remove this difficulty."

Twenty-five years ago, Mr. C. W. Peach introduced these fossils as fish—for eight years their claims were unquestioned—they were then determined to be sponges, but confessedly on imperfect materials. "For seventeen years this has remained the prevalent opinion, but it now proves to be incorrect. Mr. Peach's judgment has received the fullest justification, and we all congratulate him heartily on the fact."

3. In the third paper, Mr. Pengelly gives extracts from all the papers he has been able to ascertain which relate to Kent's Cavern, and have appeared prior to the year 1859. Amongst them the writings of Blewitt, Godwin-Austen, Owen, and Vivian, appear prominent.

III.—SCIENTIFIC JOURNALS.

1. THE QUARTERLY JOURNAL OF SCIENCE, begun in 1864, has just commenced its sixth volume, and will in future be published by Messrs. Longmans & Co.

The editors, Messrs. James Samuelson, and William Crookes, F.R.S., each contribute an original article to the January number, on "The Ethereal Hypothesis of Light" by the former, and on "The Great Solar Eclipse of 1868," by the latter gentleman. Mr. J. Arthur Phillips gives an account of "The Alkaline Lakes of California;" there is also an able Review of Dr. Bigsby's Thesaurus Siluricus, and a Notice of the principal discoveries in science during the past year; with many other topics of general interest. Besides these there are the usual Quarterly Chronicles of Archæology, Geology and Palæontology, Mineralogy, Mining, etc.

2. THE POPULAR SCIENCE REVIEW for January, contains an article on "True and False Flint Weapons, by Mr. N. Whitley, C.E. His remarks refer chiefly to the implements of the so-called Palæolithic age. "These stone implements pass, by such insensible gradations, into other forms of fractured flint, obviously the result of natural causes, that their advocates find it difficult to determine whether they are artificial or natural;" while "the implements of Neolithic age," he says, "cannot be inspected without producing the conviction of their human origin."

He regards the flint flakes, of which about 30,000 were found in one Belgian cave, associated with human bones, as formed by natural causes, some of them being afterwards selected and adapted for use by man.

He has made a large collection of these flint flakes from various localities. "They show a gradation in size from $\frac{1}{8}$ inch to 8 inches in length. A gradation in form from the roughest fracture to the most perfect flake. The good and the bad are all mingled in indiscriminate confusion; but the most degraded savage would not cast away his well-formed implements with the refuse chips. They show no additional workmanship beyond the ordinary fracture of the flint, and bear no evidence of use."

We would ask, before accepting Mr. Whitley's interpretation of these flakes, may they not be the refuse-chips left from the formation of flint implements or weapons?

3. The Comptes Rendus, tome lxvii., contains an account of the discovery of a new locality for Adamite (Arsenate of Zinc) in France.

This mineral, hitherto only observed in small quantities on some specimens of silver ores from Chañarcillo, Copiapo, Chili, has been discovered by Messrs. Gory and Boutigny in the refuse heaps of a copper mine situated at Cape Garonne, near the town of Hyères, Department du Var, France. In a qualitative examination M. Gory found arsenic, zinc, and cobalt. At the request of the finders M. Damour undertook the analysis of this interesting mineral. The following are its principal characters. The crystals are lenticular, curiously grouped and macled, sometimes coated and interpenetrated with minute acicular crystals of olivenite. Colour grey, with a slight rose tint. Some specimens show a cloudy carmine-red, somewhat similar to that of some varieties of erythrine. Hardness, a little above that of calcite. Exhibits two cleavages, with angle of 107°, as observed by M. Des Cloiseaux in the Chañarcillo mineral. Specific gravity, 4·352. M. Friedel obtained 4·338 for that from Chili. Heated in a tube disengages a little water neutral to test papers, and takes a slight bluish tint. Dissolves completely in acids, only partially soluble in caustic potash. B. B. on charcoal, melts into a blackish scoria, giving off white fumes with an arsenical odour. On cooling, leaves a white ring around the scoria, tinted with blue upon the edges. When fused with borax, or microcosmic salt, this gives the characteristic blue colour of cobalt. Deducting the cupric and cobaltic arsenates, regarded by Damour as accidental admixtures, the numbers obtained approach near to those which indicate the formula, $\dot{\mathrm{Zn}}_4\,\overset{\therefore}{\mathrm{As}}.\,\dot{\mathrm{H}}$. Isomorphous with olivenite, as observed by Des Cloiseaux in the Chili mineral. The Adamite of Cape Garonne is found in thin layers lining the fissures of a quartz rock, which is traversed by veins of sulphide and carbonate of copper, and is situated on the side of a hill more than 900 feet high, composed of Keuper Sandstone A small quantity only of this mineral has yet been obtained.—T. D.

REVIEWS.

HEALTH AND GEOLOGY COMBINED.

I. Public Health. Tenth Report of the Medical Officer of the Privy Council. With Appendix. 1867. Published 1868.

Of late some little attention has been turned to the connection between Geology and the prevalence of certain diseases. The following reports have reference to this subject.

Dr, Buchanan reports on an Outbreak of Typhoid Fever at Guild-

ford, wherein he clearly shows that its origin may be traced to a contamination of one section of the water-supply. The sufferers had been supplied with water from a new well, situated in the Chalk, which obtained its water not by percolation only, but from a fissure also in the same rock, into which it was easy for excrementitious impurities to have entered. Within ten feet of the well were various sewers; through some cause, the bricks of one of them had become loosened, some escape of its contents ensued, this saturated the Chalk around and reached the water in the well, thence the impurities were supplied to a certain portion of the inhabitants, and 21 deaths ensued from typhoid fever.

Dr. R. Thorne Thorne reports on an Epidemic of Typhoid Fever at Terling in Essex.—Every possible source of pollution both for air and water existed there. The peculiarly porous soil underlying the area was continually absorbing the filth; the water-supply of the population was derived from wells, most of them sunk in that excrement-sodden sponge of earth. In consequence, the water was contaminated, and the inhabitants one by one poisoned.

Dr. Buchanan reports on the Distribution of Phthisis as affected by Dampness of Soil.—A general sanitary enquiry entrusted to him in 1866, having appeared to show a relation between wetness of soil and prevalence of consumption, the subject was further examined with direct reference to geological considerations. The results are now published. Systematic enquiries were instituted—(1), As to the Local Distribution of Disease, and the circumstances by which it is regulated; and (2), Particular Processes of Disease were investigated in scientific detail. With the first of these enquiries only, we have to deal. Among the results, the local distribution of Pulmonary Phthisis stood in particular relief.

The Memoir is accompanied by a short account of the geological formations of Kent, Sussex, and Surrey, by William Whitaker, Esq., B.A., F.G.S., of the Geological Survey of England and Wales, and illustrated by an excellent geological map of the three counties, made up of published and unpublished Survey work. Mr. Whitaker has also furnished a small geological map of Terling, to illustrate the relations of phthisis to the character of the soil, and together with Dr. Buchanan has given (1) a short geological account of all the "Registration Districts," (except in London,) in the three counties. (2 An estimate of the population living upon each geological formation in those counties, and then a series of conclusions as to the relation between geological and topographical features, with the consumption death-rate.

The following are the general conclusions which result from this inquiry:—

(1.) Within the counties of Surrey, Kent, and Sussex, there is, broadly speaking, less phthisis among populations living on pervious soils than among populations living on impervious soils.

(2.) Within the same counties, there is less phthisis among popu-

lations living on high-lying pervious soils than among populations living on low-lying pervious soils.

(3.) Within the same counties, there is less phthisis among populations living on sloping impervious soils than among populations living on flat impervious soils.

(4.) The connection between soil and phthisis has been established in this inquiry—

(*a.*) By the existence of general agreement in phthisis-mortality between districts that have common geological and topographical features, of a nature to affect the water-holding quality of the soil.

(*b.*) By the existence of general disagreement between districts that are differently circumstanced in regard of such features; and

(*c.*) By the discovery of pretty regular concomitancy in the fluctuations of the two conditions, from much phthisis with much wetness of soil, to little phthisis with little wetness of soil.

But the connection between wet soil and phthisis came out last year in another way, which must here be recalled—

(*d.*) By the observation that phthisis had been greatly reduced in towns where the water of the soil had been artificially removed, and that it had not been reduced in other towns where the soil had not been dried.

(5.) The whole of the foregoing conclusions combine into one—which may now be affirmed generally, and not only of particular districts—*that wetness of soil is a cause of phthisis to the population living upon it.*

We have brought these reports under the notice of our readers, because we consider them of great interest as showing the very important aid that a knowledge of geology may furnish in affording a clue to the origin of pulmonary diseases. Similar valuable results may, no doubt, be looked forward to in regard to the connection between other diseases and the geological structure of a country—which will give a new value to the published maps of the Geological Survey, and greater stimulus to the study of the science; it is extremely interesting also to notice that many eminent medical men rank among the foremost of our geological leaders.

II. Geo-Theology.

I. In 1810 Major-General Twemlow[1] accidentally picked up some chalk fossils, "which then gave him the impression that the upheaved chalk downs must be part of the *garment* of the earth renewed at the Deluge." Since that date he has been busy collecting a series of specimens, which he illustrates and describes in the volume now before us. They are from various localities, and from different deposits, principally from the Chalk, and seem to have been simply collected, without reference to the mode of their occurrence. Nor does the author seem to be aware that there is a regular order of succession in the strata composing the crust of the earth. His desire is to reconcile geology with the Bible, and with this object in view he proceeds to the interpretation of the specimens he has collected, and which he has taken much pains to illustrate by photographs.

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[1] Facts and Fossils adduced to prove the Deluge of Noah, and modify the transmutation system of Darwin, with some notices regarding Indus Flint Cores. By Major-General George Twemlow. Illustrated with Photographic plates, 8vo., pp. 256. London: Simpkin & Co.

In the frontispiece we have:—

"No. 1. Head apparently of a mammal from solid Chalk, Guildford, Surrey. It is now *solid flint*, whatever it may have been originally."

"No. 2. A piece of fossil wood from under the Hog's-back, Guildford, on which four creatures appear to have clung, probably to escape diluvial waters." (!)

Among other specimens figured are: "A Pear, in solid black flint, from the Chalk;" "a Bird of Plumage, like the Bird of Paradise, it has an Echinus eating into its back;" an antediluvian Monkey from the Chalk at Guildford; fish, reptiles, and all various forms of flint are identified by the fertile imagination of Major-General Twemlow.

These and other fantastic forms of flints are the "Fossils" adduced by the author in support of a universal deluge.

Unfortunately for his argument, there are no indications of bone in any of the specimens supposed to represent vertebrate animals, and, as is well known, the silicification is simply a replacement, we cannot conceive how the author has been led to theorise on such materials.

The fruits found in the Coal-measures, the Purbeck beds, the London clay, etc., are considered by the author of this Book, to be those (mentioned in Genesis i. 29) which were to serve as meat for man.(!)

The water-supply for the Deluge is touched upon by Major-General Twemlow. Volcanic eruptions and artesian wells are called into play to give evidence of the "waters under the earth." As fish have been found in these subterranean reservoirs, the author asks whether some of the Saurian monsters may not have had their abodes in them, and been "upheaved when '*the fountains of the great deep were broken up.*'"

Major Twemlow's Palæontological aspirations may be judged from the following expression:—

"If some of the five hundred species of Ammonites should prove to be the gigantic Planorbi," which "fed in the primæval gardens and forests," etc.!!

Again, he says, "We do not find fossils now forming, or very rarely." (!) We recommend to him a careful perusal of Lyell's Principles of Geology.

In regard to his objections to the Transmutation system of Darwin, we need say nothing; they depend upon the acceptation of his "Facts and Fossils adduced to prove the Deluge."

The Flint Cores alluded to were described and delineated in the Geological Magazine, Vol. III. p. 423.

We have been highly amused with this book of Major Twemlow's;

its highest recommendation is its harmless absurdity. We have seldom seen a better "Book of Nonsense."

II. The Rev. Mr. Kirk[1] has come under our notice before. In the GEOLOGICAL MAGAZINE for July, 1866, a short review was published of his "Age of Man Geologically Considered in its Bearings on the Truths of the Bible." In this book the author displayed his great powers of illogical reasoning, and no inconsiderable amount of disrespect towards Sir Charles Lyell.

We regret to find but little improvement either in Mr. Kirk's geology or his reasoning. He talks of "the fond partiality with which favourite hypotheses are almost worshipped," and then tries to throw ridicule on some of the generally accepted inferences regarding bygone periods, and to substitute in their stead hypotheses invented by himself for the professed purpose of supporting the Mosaic writings. His reasoning in regard to time is especially faulty.

In speaking of the upheavals and downthrows, Mr. Kirk says, "It is amusing to see how happy many great minds are in their enjoyment of vertical motion alone. Their sea-beds sink to nowhere, and their mountains and continents rise from nowhere; but they themselves are not troubled with the incongruity in the dream! Is it not possible that there may be a horizontal motion of the earth's surface?"

Satisfied with the simple asking of the question, he proceeds, "If, then, we give up the merely vertical movement of upheaval and subsidence, with latitude maintained, and believe that since half an English county could be turned over like a turf on its grassy side, any number of such formations could be pushed along from tropical to temperate, and thence to arctic positions on the great globe. We have, at least, *one line of thought* marked off, by which changes of climate, and all consequent changes of species, may ultimately be accounted for."

In this way he elucidates the origin of the London clay! "Is it not evident that this clay was formed within the tropics, and that somehow it has been removed, until it lies in our northern latitude?"

And he concludes, that "we must recast our ideas of the extinction of species, and alter our views of what is called geological time."

Major Twemlow gives us quite as good a theory to account for the London clay. He talks of a mighty rush of waters bringing tropical fruit to the valley of the Thames, and spreading drift and commingling fossils as we find them!

That such theories should be promulgated at the present day seems astonishing; and the publication of such papers would greatly impede the progress of Geological Science, if the writers were only as able as they are willing to make proselytes to their own views.

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[1] Geological Theories: being a Discourse on the Past and Present Relations of Geological Science to the Sacred Scriptures. Read before the Victoria Institute. By the Rev. John Kirk. 8vo. pp. 51, London.

The great delight of such men as Mr. Kirk is to perch themselves on some great man,—like Sir Charles Lyell for example—and then, in the words of the fable of "The Fly on the coach-wheel," to exclaim "See what a dust I make!" But, like the fly, they don't attract much notice after all.

III. Mr. Pattison's pamphlet,[1] both in style and matter, is well written, and deserves a far more thoughtful consideration than the foregoing Essays, being written by a gentleman who is a careful observer, and a very good geologist. It is likewise an attempt at a reconciliation of Geology with the Scriptures. The evidence of fossils is dismissed by the author with the remark, that the Scriptures do not refer to them at all.

Mr. Pattison's main argument is, that the antiquity of man ought not to be so far extended beyond the date assigned by Scripture Chronologists, because "Geology affords no reliable scale of time." But, may we not venture to ask, is Archdeacon Usher's chronology more indisputable than that of the Hindoos or Chinese? We cannot tell exactly how long it has taken to deposit the beds of gravel, clay, and brick-earth containing the Flint Implements; for the widening, scooping out, and partial refilling of our present valleys; for the formation of peat, containing stone, bronze, and iron implements, corresponding pretty nearly with the successive flourishing of the Scotch fir, the oak, and the beech, and indicating three different periods of civilization. "Nevertheless," to quote Mr. Prestwich, "just as, though ignorant of the precise height and size of a mountain-range seen in the distance, we need not wait for trigonometrical measurements to feel satisfied in our minds of the magnitude of the distant peaks; so with this geological epoch, we see and know enough of it to feel how distant it is from our time, and yet we are not in a position at present to solve with accuracy the curious and interesting problem of its precise age." [Phil. Trans. 1864, p. 303.]

REPORTS AND PROCEEDINGS.

Geological Society of London.—December 23rd, 1868.—Professor T. H. Huxley, LL.D., F.R.S., President, in the chair. 1. "On the so-called 'Eozoonal' Rock." By Prof. W. King and Dr, T. H. Rowney. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., V.P.G.S.

The authors noticed that, since the reading of their former communication in 1866, further descriptions of *Eozoon* have been published by Hochstetter, Gümbel, Carpenter, Dawson, and Logan; and after a few words on those by the first two, they proceeded to criticise the others more fully, intimating that the English and Canadian observers have by no means mastered all the difficulties of the subject, nor answered the objections brought forward by them.

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[1] New Facts and Old Records; A Plea for Genesis. By S. R. Pattison, F.G.S. 8vo. pp. 32. London: Jackson & Co.

In the course of these remarks, Messrs. King and Rowney, objecting to the specimen from Tudor, of which they have seen the photograph, and which was described and figured in 1867 (Q. J. G. S., No. 91), suggested that it is nothing more than the result of infiltration of carbonate of lime, with entangled impurities, between two layers of the sandy limestone. They also stated their belief that the term "Eozoonal" is applicable to any of the ophites they describe, inasmuch as it was contended that the structure of the latter is similar to that of the Canadian rock containing the so-called *Eozoon.*

The authors then proceeded to treat of the supposed *foraminiferal* characters of "Eozoon." First, as to the "cell-wall" or "nummuline layer," they advanced repeated evidence of the value of their former proofs that the typical form is due to acidulate serpentine (or modified chrysotile) of inorganic origin, having examined, besides others, a Canadian specimen presented by Dr. Carpenter. Secondly, nothing new was adduced with regard to the mineral structure of the so-called "intermediate skeleton." Thirdly, in proof that the "chamber-casts" are not of organic origin, the authors referred to their former work, and stated that chondodite and pyrallolite may be added to the list of minerals that occur, as such disseminated in limestones. They thought it strange that a carbonate, as well as a silicate, should not have been found filling the so-called chambers; and they decidedly refused to accept the Tudor specimen having some tubuli filled with calcite, to which they suppose Dawson refers when speaking of chambers filled with calcite, as a case in point; they were unacquainted with any published instances of this mineral being an infilling. Fourthly, reiterating their observations on the so-called "canal-system," they suggested that the globoso-vermicular bodies noticed by Dawson and Gümbel may be metaxite; and they insisted on the difficulty of explaining the presence of isolated unbroken tube-casts in patches of pure limestone. The Madoc specimen, described by Dawson as having its "canals" and "chambers" filled with calcite, was next referred to; and it was argued that the so-called calcite, both in this and in another specimen, described by Carpenter, is doubtful and not proved; for they had not been able to confirm the accuracy of the observations in these cases, having examined a Canadian specimen, presented by Dr. Carpenter as an example of the kind, which had in it "homogeneous and structureless forms of the canal-system" that were not dissolved in the decalcification. Fifthly, the organic nature of the so-called "stolons," was regarded as quite disproved. *Mineralogical* considerations of Eozoonal rocks were next entered upon; and from the study of Canadian specimens, and of others from Connemara and Neybiggen (?), described in full, the authors concluded that they fully prove the "canal-system," "chamber-casts," and "nummuline layer" to be structural and inorganic modifications of serpentine—that the whole have originated from the change or waste of granules, plates, etc., of serpentine; and they incline to the belief that the calcite of the "intermediate skeleton" is pseudomorphic after one or other form of serpentine by infiltration and replacement.

The rounded form of the granular masses of chondrodite, coccolite etc., in some limestones was also referred by the authors to the gradual removal of their surfaces by deep-seated hydrothermal agency.

It was then argued that the organic nature of *Eozoon* cannot be supported by the cumulative evidence afforded by the combination of foraminiferal features; for these features, *combined* and due to purely mineral paragenesis, had occurred to the authors in certain ophites, though some are wanting in other ophites, just as they are not always present in the Eozoonal rock of Canada.

Serpentine has been described as having been deposited in the cavities of Eozoon, and having taken the place of its sarcode; but the authors criticised all the quoted analogies of such a precipitation of any siliceo-magnesian substance, disbelieved them, and put aside glauconitic infiltration as beside the question.

Considered *geologically*, with reference to its occurrence in a metamorphic rock, the authors regarded the *Eozoon* as an organic impossibility; and they asked why it should never be found in anything but crystalline or semi-crystalline rocks—in ophites or ophicalcites of widely different ages. Particularly they found Eozoonal structure in the Liassic ophite of Skye; and this they described in full. They criticised Sterry Hunt's change of opinion, who used to think that the serpentinous rocks of Canada were once earthy amorphous silicates, and afterwards metamorphosed, but who now supposes they were deposited in a crystalline state; and they asked why, if so, may not all the Laurentian rocks have been so deposited? In conclusion, they totally denied that Eozoonal structure has anything to do with any organism, and repeated that, like all analogous conditions of serpentine, chondrodite, etc., it is of purely mineral origin.

DISCUSSION.—Prof. Ramsay had been struck long ago by the organic appearance of the structure now regarded as *Eozoon.* He had also felt a difficulty in accounting for the existence of large masses of limestone, except by the operation of organisms living in the sea, in which such deposits had been formed. He could not imagine the sea-water so overcharged with calcareous matter as spontaneously to deposit limestone.

Mr. Parker, on examining the various parts of the *Eozoon* as shown him by Dr. Carpenter, had been able to recognise in them similar structures to what he had already met with in recent Foraminifera.

Prof. T. Rupert Jones accounted for the difficulty that sometimes existed in recognizing Eozoonal structure by the contortion of the containing beds subsequently to their deposition.

Dr. Duncan had been struck in the earlier known specimens of *Eozoon* by the shape of the tubules of the canals: he had never seen similar outlines in inorganic bodies.

Dr. Carpenter said that he need not repeat the grounds on which he regarded this as an organic structure. He objected to criticisms unless founded on examination of actual specimens. Sir Wm. Logan had been first led to regard the *Eozoon* as organic by finding alternations of calcareous and siliceous layers in various minerals. A specimen which Sir William had brought from Canada contained much iron, and had the canal system wonderfully preserved; and it presented this character—that the larger branches were infiltrated with serpentine, and the middle branches with sulphide of iron, while the smallest branches were filled with carbonate of lime, of the same nature as the matrix. It was only under a favourable light that these smaller tubes were visible, as the calcite in them was of the same crystalline character as the surrounding network. This was conclusive evidence of the structure not arising from the mere infiltration of one chemical substance into another. Moreover this foreign matter could not penetrate the cleavage-planes. When cut, some specimens had given out a strong odour of musk, which they to some extent still retained. This, again, seemed to be evidence of organic origin. He regretted that Prof. King had not examined the large collection of specimens in his (Dr. Carpenter's) collection. Recent Foraminifera, when decalcified, exhibited precisely the same asbestiform layer round the chamber-cast as the fossil *Eozoon*. Different genera of Foraminifera in recent seas were infiltrated by different minerals, which presented some analogy with the condition of the fossil under consideration. In the great seas of the present day, at various depths and temperatures, was a large extension of sarcodic substance, and in this there were Rhizopods with and without shells, but of similar low structure; and such forms might have continued in existence through any length of time, so that the occurrence of *Eozoon* so far down as Jurassic times could afford no matter for surprise. He would not be astonished even if such a structure as *Eozoon* were found in deep-sea dredgings of the present day.

The President mentioned the *Bathybius*, which he has found with coccoliths and other forms in deep-sea soundings. In some newer specimens of Atlantic mud given him by Dr. Carpenter he had found *Bathybius* forming a sort of network somewhat similar to the plasmodia of botanists. He could not call it either plant or animal. It was, however, a living substance, susceptible of apparently indefinite growth. This removed one of the difficulties in believing in the wide extension of the *Eozoon*. The Hydrographer had since sent him the soundings taken by Captain Shortland in 'The Hydra.' In soundings from 2,800 fathoms in the Arabian Gulf *Bathybius* was plentiful; and over an area 7000 miles long the same organism occurred in abundance. He agreed in thinking it possible that such organisms might have gone on living from the earliest geological times.

In answer to Prof. Ramsay, the President stated that the soundings in which the *Bathybius* occurs alone, as analyzed by Dr. Frankland, contained 1½ per cent. of nitrogenous organic matter.

2. "Notes on the Geology of China, with more especial reference to the provinces of the Lower Yungtsi." By Thomas W. Kingsmill, Esq. Communicated by the President.

The sedimentary deposits of the south of China were described as commencing at the base with a series of coarse grits and sandstones, having a thickness of about 12,000 feet, and overlain conformably by limestones and shales (with coal in the lower part), attaining a thickness of between 6000 and 8000 feet. The whole of these rocks were described by the author as the "Tung-ting Series." In the Nanking district this formation is succeeded by sandstones, grits, and conglomerates, which the author has grouped together under the name of the "Chung-shan Series." Its uppermost member contains beds of coal, and possesses an unknown thickness; but the remaining beds are together about 2400 feet thick. Mr. Kingsmill described in detail the geological relations and geographical extension of these rock-masses; he then gave a sketch of the superficial deposits, which occupy an important position in the geology of China, and from the older of which Mammalian bones and teeth have been obtained; and he concluded by stating that he had been uniformly unsuccessful in his frequent searches for traces of Glacial action.

Discussion.—The President remarked that if the South of China had been dry land since so early a period, the fauna might have been expected to resemble that of the Siwalik Hills. Among the teeth was the molar of a very small horse, presenting some of the characters of *Hippotherium* or *Hipparion*, which might *possibly* be of Miocene date.

Prof. T. Rupert Jones alluded to the general parallelism of the axial folds of the strata with the coast-line, and to the similar strike of the gold-bearing rocks in the Gulf of Petchele, and mentioned that Cycadaceous remains occurred in the Coal of some parts of Germany as in China.

Mr. W. Boyd Dawkins remarked that one of the equine molars was the largest of the class he had seen. He agreed with the President as to the smaller molar. He was unable, from the specimens, to determine whether they were Miocene or Pliocene. He mentioned the discovery in the Laterite of India of a portion of a human femur of most remarkably slender make.

II. January 13th, 1869.—1. "On *Hyperodapedon*. By Professor T. H. Huxley, LL.D., F.R.S., Pres. G.S.

The author described the characters of the genus *Hyperodapedon*, dwelling especially upon those presented by the head and dentition. The head presents indications of a bone forming a second zygomatic arch on each side; the upper jaw is produced and bent downwards, forming a strong beak; and the lower jaw is produced on each side of the symphysis into a pointed process, between which the decurved beak of the upper jaw is received. The maxillary and palatine teeth are arranged in rows, and present some resemblance to the large nails in the sole of a boot; they are inserted on each side of the upper jaw upon the sloping sides of a deep grove, and are worn down and polished by the action of the mandibular teeth, which form a continuous and very close single series along the upper edge of the mandible. The author remarked upon this peculiarity of arrangement, which, he said, enables the teeth of *Hyperodapedon* to be recognized wherever they may occur. The vertebræ have their centra slightly concavè at each extremity. The other known parts of the skeleton described by the author were the ribs, scapula, coracoid, and part of the humerus, the pelvis, femur, and proximal ends of the tibia and fibula, and the abdominal false-ribs, which are largely developed in this Reptile.

The author declared the affinities of *Hyperodapedon* to be decidedly Lacertilian. Its nearest fossil ally is the Triassic genus *Rhynchosaurus*, and in the present day its type of structure is most clearly reproduced by the singular genus *Sphenodon* = (*Hatteria*) of New Zealand. In its habits *Hyperodapedon* was probably terrestrial, or perhaps fluviatile; in Warwickshire and India it is associated with *Labyrinthodonts*. The remains hitherto met with do not justify the formation of more than one species, *Hyperodapedon Gordoni;* and the genus ranges from Britian to Central India, indicating a great extent of dry land during the period to which it belongs.

Specimens of *Hyperodapedon* from the Trias of Warwickshire, collected many years ago by Dr. Lloyd, were exhibited; but in discussing the question whether *Hyperodapedon* is to be regarded as determining the Triassic age of any rock in which it may be found, the author referred to the fact that Crocodiles bridge over the whole interval between the Mesozoic and existing conditions, and *Beryx* in like manner connects the Cretaceous with our present fish fauna. As *Hyperodapedon* is at least as nearly allied to the existing genus *Sphenodon* (= *Hatteria*) as it is to the Triassic *Rhynchosaurus*, the author inquires why may it not have inhabited the dry land of the Permian, Carboniferous, or Devonian period? Carrying the idea thus raised still further, he indicates from certain relations between the Reptilian faunæ of Europe, S. Africa, and India at the period when *Hyperodapedon* lived in the first and third of these localities, not only that there must then have been a vast extent of continental land, but that this may have persisted with but little change in the nature of its inhabitants, while the fauna of the neighbouring seas underwent great alterations. He remarked that our Geological chronology rested too much upon a marine foundation, and that such a persistence of dry land as was now suggested by him was not only possible but, in the present case, probable. He suggested the use of Conybeare's term "Poikilitic" for the series of deposits containing the remains of terrestrial and fluviatile plants and animals, and corresponding with the marine beds denominated Permian and Triassic. Finally, the author remarked upon the important light thrown upon the question of the geographical distribution of animals by the discovery of these reptiles and other recently detected fossils, and upon the interest attaching to them from their high grade of development. The five great classes of Vertebrata were represented during the "poikilitic" epoch by species so high in the scale that we can hardly doubt their having been preceded by other forms, so that some of us may yet hope to see the fossil remains of a Silurian Mammal.

Sir R. I. Murchison (who occupied the chair during the reading of the foregoing paper by the President, Prof. Huxley), argued in favour of the overwhelming importance of palæontological evidence, and maintained that *Hyperodapedon* was Triassic. He objected to the use of the term "poikilitic," which was merely indicative of the spotted character of the beds, and protested against the mingling of the Permian and Triassic series. [The discussion of the above and the succeeding paper was then agreed to be taken together.]

2. "On the Locality of a new Specimen of *Hyperodapedon* on the South Coast of Devon.' By W. Whitaker, Esq., F.G.S.

The author described the section presented by the South Devon coast westward from the great landslip at Dowlands. The cliffs here show Rhætic beds passing down into Red Marls of Upper Triassic age, which have greenish layers among them, favouring the view that the Rhætic beds might as well be classed with the Trias as with the Lias. Below these beds are Red Marls and Sandstones, and at Budleigh Salterton a bed of quartzite pebbles occurs. West of the Exe the cliffs are of sandstone with layers of breccia; and beyond Dawlish the breccia gradually predominates, until towards Teignmouth the cliffs are almost wholly formed of it. This breccia forms the base of the New Red of Devonshire. The thickness of the whole series is several thousand feet—Mr. Pengelly estimates that it may be four miles or more. The jaw of *Hyperodapedon* referred to by Professor Huxley was found in the sandstone on the left bank of the Otter, immediately above the Budleigh Salterton pebble-bed, in the lower part of the uppermost bed of Sandstone, which, with the other sandstones and marl-beds, the author regarded as belonging to the Keuper. He referred to the opinions of Mr. Pengelly and Mr. Ormerod, and suggested that the breccias might possibly be of Permian age.

DISCUSSION.—Sir Charles Lyell, referring to the occurrence of *Hyperodapedon* with *Stegonolepis* and *Telerpeton* in the uppermost sandstones of Elgin, remarked that he came to the conclusion that these beds were Triassic in 1859, and that Mr. Symonds had in that year stated them to be the equivalent of the *Rhynchosaurus*-sandstones of Shropshire.

Professor Ramsay regarded the Red Marls and Sandstones described by Mr. Whitaker as Keuper, and the lower members of his section as of Permian age. He confirmed Professor Huxley's views as to the existence of a great extent of continental land at the epoch when *Hyperodapedon* and the Reptiles associated with it were in existence, and remarked that these Reptiles inhabited the shores of the great salt lakes of the Triassic land. He objected to the use of the term "poikilitic," and remarked that if the idea embodied by Professor Huxley under it were to be accepted, it would have to be extended to all terrestrial deposits from the Silurian period to the present day.

Dr. Günther referred to his description of *Sphenodon* (= *Hatteria*), and remarked that in that genus there are uncinate processes on the ribs, as in Birds, which do not exist in *Hyperodapedon*. He remarked upon the resemblance of the beak in the latter to that of the Tortoises, especially *Trionyx*, and suggested that the jaws might have had a horny covering.

Dr. Meryon inquired as to the implantation of the teeth in the jaws of *Hyperodapedon*, and suggested that the position and direction of the orbits were not accordant with terrestrial habits, and also that the absence of processes on the ribs indicated a flexibility of the body consistent with a fluviatile mode of life.

Professor Huxley showed that no conclusion could be drawn from the want of processes on the ribs or the position of the orbits as to the habits of the animals, and remarked that the processes in *Sphenodon* were not anchylosed to the ribs; he considered it possible, but not probable, that the jaws had a horny covering. He stated that in using the term "poikilitic," he was desirous of indicating that while several marine formations with changing forms of life succeeded each other, the terrestrial fauna may, in certain cases, have been continuous. He believed that terrestrial forms were at least as persistent as marine.

Mr. Carruthers remarked that the Permian vegetation showed Mesozoic affinities, and in fact that the commencement of the Mesozoic flora was to be sought in the Permian.

Norwich Geological Society.—The first monthly meeting for the current year, of the Norwich Geological Society was held on the 14th January, at the Museum, the President, the Rev. J. Gunn, F.G.S., in the chair. The President exhibited a fine humerus of a cetacean, dredged up off Yarmouth, and now in Mr. J. J. Owles' collection. It shows marks of having been partially cut through by some sharp instrument, and numerous holes, which, it is presumed, were bored by the *Pholas*. Mr. Fitch called attention to a magnificent fossil Ammonite, which is of great interest, as being the first flint Ammonite derived from the Chalk in which the septa are shown. The President said there was a specimen in the Museum, which showed the septa, and another in the possession of Mr. Wright, of Buxton. These were, however, obtained from the Boulder-till, and not from the Chalk. Then followed a discussion on some Piles recently discovered at Trowse, of which coloured diagrams and sections had been prepared by Mr. Reeve to show their position. These were explained by Mr. J. E. Taylor. As the investigations have not yet been completed, we shall defer a more lengthened notice of their discovery. Although the position of the piles at Trowse differed in one respect, namely, in their being placed in regular lines, from the position of those used for crannoges, yet the argument seemed in favour of their having been applied to the formation of such a dwelling, and it was strengthened by the state-

ment of Mr. John Evans and Mr. Flower, that the whole district abounds with fragments of flint implements, which shows that the country was occupied at the time when crannoges were constructed.

The President then read the following paper:—"On the Discovery of new Beds of Crag." Much credit was gained by the Norwich Geological Society through the labours of Mr. Taylor in ascertaining the distinction between the fluvio-marine, and the upper marine portion of the Norwich Crag. The position of these crags is beneath the Chillesford clay, which appears above them in the Bramerton section. Since that discovery, the *Tellina Balthica* Crag has been observed at Belaugh, Coltishall, Wroxham, Horstead, Sherringham, and Weybourne, above the Chillesford Clay, of a more Arctic character, and approaching nearer to the Glacial period, which is evidenced by the Lower Boulder-clay or Till. As this crag will be descrided by Mr. Harmer, Mr. Gunn said he would leave it in his hands, and proceed to mention another bed of crag at Sherringham, which occurs far above the *Tellina Balthica* bed—it rests on the Upper Boulder-clay. The deposit is 15 feet in thickness, and is composed of sand with shells, which are so abundant as to justify the term "Crag" being applied to it. Most of the shells are in a very fragmentary state, so much so, that only one species could be determined—it is, according to Mr. Searles Wood, a thickened form of *Tellina Balthica*.—*Norwich Mercury*, Jan. 16, 1869.

CORRESPONDENCE.

THE PLEISTOCENE FRESH-WATER DEPOSIT AT HACKNEY DOWNS.

SIR,—I must again trespass on your valuable space for a few final lines with reference to the above subject. Since my letter appeared in your journal I have seen Mr. Grugeon, and understand that some shells which he gave me early in the year 1866 were collected by Mr. Skertchly; I was not aware of this before. The facts of the case are as follows. I called at Mr. Grugeon's house; a few of the Hackney Down shells were lying there; he told me I could have them, and then gave me to understand that they were collected by his son, but he now tells me they came from Mr. Skertchly. They were of the commoner species, unsorted and unnamed, and it is upon this only that the charge contained in GEOLOGICAL MAGAZINE, No. 50, is brought against me, and which in effect is, that Mr. Skertchly sent me "a set" of the Hackney Down shells, and that I afterwards published a list of them as my own. I leave your readers to judge how far such an accusation was justified by the facts of the case, and will only add, in conclusion, that the species enumerated in the Geological Repertory were my own collecting, the result of many visits to the spot, and of much time spent at home in examining the sand, etc., with a magnifyer, for the rarer and more minute species.

ISLINGTON, 1868. GEORGE J. SMITH.

CORBICULA (*CYRENA*) *FLUMINALIS* IN CAPE COLONY.

SIR,—This species, which is extinct—though very abundant in a fossil state in various parts of Europe—I found living in the Vaal river, in South Africa, in July last. I found it rather abundant about three miles from the junction of the Vaal and Great Orange rivers, about 29° south latitude. I procured about twenty specimens. The river here is rather rapid, though not deep, and runs over a bed of stones, mostly small boulders of Trap, from three to six or eight inches in diameter. Living examples have long been known from the River Nile, and there are also some specimens in the British Museum having the locality of Natal attached to them; but I believe these are the first that have been found in Cape Colony. Between Natal and Cape Colony are the Drachenberg and other ranges of mountains, yet this species of *Cyrena* seems to be the same from both localities. I am expecting these specimens in a case which was packed before I left South Africa. In England this species is abundant, though extinct in many of our brick-clays, associated with remains of the Elephant, Rhinoceros, Hippopotamus, etc.; and in South Africa the same genera of animals still exist with this little shell, although during the last twenty years the larger animals are driven further up the country, and but seldom appear in these haunts. About the time, however, that I was in Hope Town two Hippopotami were reported in the Great Orange River near Hope Town, and many persons went out after them, but with no success, although I believe some shots were fired, but the tracks of the animals were visible, and were said to be those of an adult and young animal.—James R. Gregory.

PETROLOGY AND LITHOLOGY.

Sir.—In the January number of the Quarterly Journal of Science, the reviewer of the progress of Mineralogy during the last quarter says, while noticing new works on Petrology—" Probably it would be difficult to point to any branch of natural science which at the present time occupies a more unsatisfactory position in this country than that science which, according as it is pursued in the field or in the cabinet has been variously designated Petrology or Lithology, in other words, *the study of rocks, as distinguished from that of minerals.* No one can gainsay the first part of this quotation, as without doubt books in the English language on both Lithology and Petrology, especially the latter, are sadly required, the only work at all approaching to the latter science being Lawrence's translation of Cotta, and any one who has studied it, must see how little the true science of Petrology has been regarded in the compilation of that book. But to return to the quotation—the latter part (now printed in italics) seems to be highly objectional, as in its present form it can scarcely fail to mislead students into imagining that Petrology is simply the study of rocks in any form, while Lithology is the study of minerals; when in reality the former is confined to the study of *rocks in mass*, and the latter to *pieces of rock*; by which means a rock may lithologically belong to one class, and petrologically to another. As for instance many of Cotta's quartziferous porphyries are lithologically granites, as they contain quartz, felspar and mica, while petrologically they are Felstones. A geologist divides rocks petrologically or into their *natural divisions*, and a mineralogist lithologically, as they wish to make a multiplicity of " distinct varieties." The difference between Petrology and Lithology has been fully explained by Mr. Forbes in a recent number of the Popular Science Review, and previously by Professor Jukes in his Manual. The reviewer in the Quarterly Journal of Science, by the context, would seem to be quite aware of the proper difference between Lithology and Petrology, my only excuse, therefore, for occupying any of your space is the vague way he expresses himself, which undoubtedly must mislead all young geologists. G. H. Kinahan.

Geological Survey of Ireland,
Recess, Connemara.

THE FETISH WORSHIP OF FOSSILS.

Sir,—The subject-matter of my letter, as indicated by the above heading, has upon various occasions pressed itself on my notice during my visits to collections belonging to private individuals, but more especially to soi-disant scientific persons, in various parts of England; and I think that a ventilation of it may do good by calling attention to a reform which is much needed.

First of all, I will describe what I have seen in some of the "Arcanas of Science." Imagine a series of glass-cases and drawers crammed with specimens augmented in number in a *duplicate* ratio, guiltless of labels, piled one on another, "in confusion worse confounded," suggestive alike of the interior of a *marine* store, and of an attempt to give a practical illustration of the probable scheme of Creation according to the Mosaic account. These collections belong to Fossilists whose ignorance of Palæontology reminds one of the Naturalists of the old school, whom the late E. Forbes used to describe as examining animals as though they were merely skins filled with straw, and whose scientific acumen displays itself in estimating the worth of a specimen by its *uniqueness*. The "minatus amor natendi" is strong in the minds of these worthies, and to part with any of their duplicates would be in their opinion to run the risk of losing a future chance of immortalizing themselves as the fortunate possessors of some new and *unique* species.

It is probable that I may have cast upon me the dregs of the "odium theologicum" which was poured out from the "phials of wrath" with such remarkable success during the late election; but if I can procure for some neglected pre-Adamite relic "a *local* habitation and a *name*" in some county museum, which would otherwise be fated in all probability to point a moral and adorn a grotto in a country village, I shall consider myself amply recompensed.

Example being better than precept, let me refer to the munificent gift of fossils lately made to the Norwich Museum by one of your reverend contributors. Philo-taxis.

Bœotia Trans-Avoniensis, *January*, 1869.

OBITUARY.

George Victor Du Noyer.—On the third day of January, at Antrim, where he was engaged superintending the Geological Survey of the North of Ireland, died George Victor Du Noyer, M.R.I.A., F.R.G.S.I., etc. etc.; District Surveyor of H.M. Geological Survey of Ireland. This gentleman's name is well known in connection with not only the Geology but also the Archæology of Ireland; and there is scarcely a work that has been published within the last quarter of a century on either of these subjects in which Ireland is mentioned but his name appears. About thirty years ago, when still quite a boy, he was appointed to the Geological Branch of the Ordinance Survey of Ireland, then commenced under the superintendance of the late General Portlock. After that branch was given up he served for some time on the Archæological Section of the same service under the great Petrie, and subsequently, when the Geological Survey of the United Kingdom was resumed under the superintendence of the late Sir Henry de la Beche, he again joined the Irish branch of that service, and continued on it until his sudden and regretted early death by scarlet fever after four days' illness. Mr. Du Noyer, on account of his long period of service, was more or less acquainted with the whole of Ireland, and has enriched many of the Memoirs of the Survey with his spirited Geological Sketches. They will also be found in "Murchison's Siluria," "Jukes' Manual," "Jukes' Popular Geology," and many other works on the same subject; while Griffith's and M'Coy's Palæontological Plates owe much to his pencil. Formerly he published many valuable and interesting papers in the Proceedings of the Royal Irish Academy, the Proceedings of the Dublin Geological Society, the Geologist, etc.; but of late years he has altogether confined himself to writing for the Memoirs of the Government Survey, save a few short papers read before the Royal Geological Society of Ireland and the Geological Society of London.

While engaged in the geological examination of Ireland, a love of archæology having been imbibed during his early life with Petrie, he studied and sketched the ancient structures both historic and prehistoric, and has established for himself a lasting monument in *The Du Noyer Sketches.* These consist of six large volumes of original drawings, which he presented to the Royal Irish Academy, and for this generous and patriotic act he was presented with its life membership. He was also one of the original members of the "Kilkenny Archælogical Society," now the "Historical and Archæological Association of Ireland," and at the time of his death was their provincial Honorary Secretary for the province of Ulster. During his geological researches in the Dingle promontory, he discovered the pre-historic city of Faha, of which he made elaborate drawings and plans illustrative of its cahers, raths, cloghauns, etc. Subsequently he wrote an account of them and read it before the British Association at their last meeting in Dublin, which afterwards was published by the Archæological Society of London. While in the county of Meath, he superintended the opening of the pre-historic carns Je Danaan at Lough Crew, and made minute drawings of the numerous archaic sculptures that covered the sides and pillars of the internal chambers of these ancient tombs. Of this discovery, only a short notice, with a few of the most characteristic sketches was published in the journal of the Kilkenny Archæological Society. However, it was intended to publish a full account, but the death of the proprietor, Mr. Nappen, of Loughern, delayed it, and now it is to be hoped that the lamented and early death of Mr. Du Noyer will not deprive the archæological world of this treat. Of late years he had paid particular attention to the Megalithic structures known by the general name of Cromlechs, and was publishing in the Journal of the Historical and Archæological Association of Ireland an interesting and most instructive series of papers showing their mode of construction and their uses.

The principle official geological publications with which Mr. Du Noyer was connected, are as follows:—Forty-eight sheets of the Map of Ireland, with seventeen memoirs. Of the latter, those calling for special notice are the explanations to accompany sheets 102 and 112; sheets 160, 161, and 172; sheets 167, 168, 178, and 179; sheet 184; also sheets 185, 186. The two last memoirs illustrate the parts of Cork and Kerry in the neighbourhood of the far-famed lakes of Killarney, they being enriched by thirteen of the author's sketches—all so spirited, that it is impossible to say which is the best, besides numerous maps and diagrams. The first of those enumerated above illustrates parts of the counties of Dublin and Meath; the second, the Dingle promontory in the county of Kerry, and the third, parts of the counties of Waterford, Wexford, Kilkenny, and Tipperary. To the last two, we would draw particular attention, more especially on account of the sketches, which for truthfullness and artistic skill will be rivalled in few, if any, geological works, and the loss of whose author will, we fear, subtract not a little from the beauty and interest of the future memoirs of the Geological Survey of Ireland.

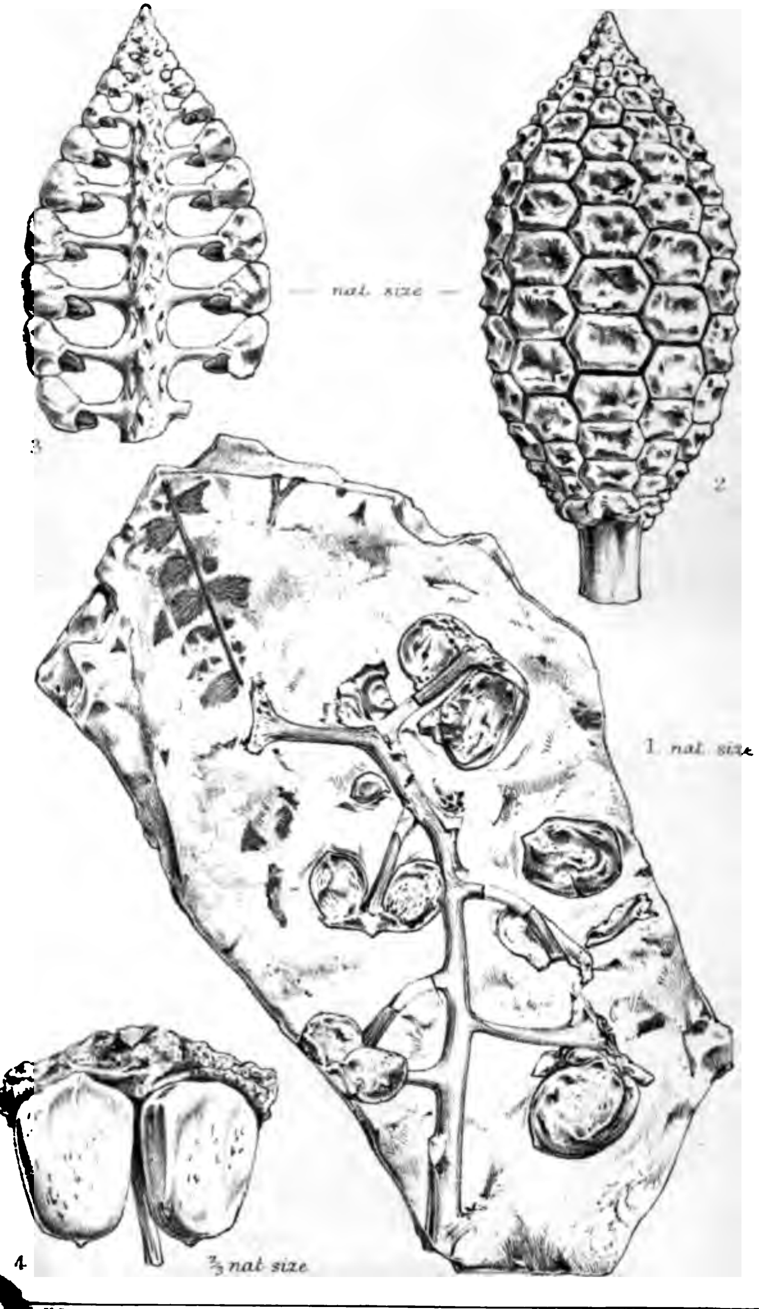
Mr. Du Noyer was of French extraction, he being the lineal descendant of the Chevalier du Noyer, his ancestors having come to Ireland as refugees. He was a Royal Arch Mason, having been initiated into that ancient order under the warrant of the Clonmel Lodge. By his death the post of District Surveyor of the Geological Survey of Ireland is vacant. In the middle of December he delivered interesting and instructive lectures to the inhabitants of Belfast. At the first meetings in this year both the members of the Royal Irish Academy and of the Royal Geological Society of Ireland had to lament the loss of one of their most eminent fellows, and—to many—of an intimate friend. At the meeting of each of these Societies his extreme private worth and his valuable services to his adopted country were mentioned, and resolutions were passed that the influences of the Societies should be used, in the hope that his long and faithful services may be recognised by Her Majesty's Government granting a pension to his widow. We heartily join in the hope that the influence of these Societies may not be exerted in vain.—G.H.K.

James David Forbes, D.C.L., LL.D., F.R.S.L. & E., F.G.S., Principal of St. Salvator's and St. Leonard's College, St. Andrews, was the youngest son of Sir William Forbes, the seventh Baronet of Pitsligo, in the county of Aberdeen. His death has just been recorded (see *Illustrated London News*, Jan. 16, 1869). Principal Forbes was born April 20, 1808, and was educated at the University of Edinburgh, where he obtained several prizes, and where he held the Professorship of Natural Philosophy from 1833 until 1860. He was the author of several papers on heat, and other works on Physical Science; "Travels in the Alps of Savoy," "Norway and its Glaciers," "Papers on the Theory of Glaciers," etc. He received the Keith medal of the Royal Society of Edinburgh, and the Rumford and Royal medals of the Royal Society of London, for various papers he prepared, and which were published in the Transactions of those bodies. He was elected a Fellow of the Geological Society of London in 1831, but read no papers before that Society. In 1843 he married Alicia, daughter of George Wauchope, Esq., of Edinburgh, and by her, who survives him, he leaves issue two sons and two daughters. Principal Forbes is succeeded in the College at St. Andrews by Professor J. C. Shairp, M.A.

MISCELLANEOUS.

LITHODOMOUS BORINGS 667 FT. ABOVE THE SEA.—Mr. Mackintosh, F.G.S., who wrote on *Pholas*-borings near Torquay, in this MAGAZINE for July, 1867, has just discovered what he believes to be Lithodomous perforations up to 667 ft. above the sea on the eastern side of Hampsfell, on the border of Morecambe Bay. It is with great difficulty they can be detected at high altitudes, as they almost invariably occur on the protected or overhanging sides of rocks or boulders. It would appear that up to 250 ft. above the sea, Mr. Boulton and other inhabitants of Furness have been familiar with these perforations for many years, without having studied their importance in a theoretical point of view. Though rain has made numerous *rough* holes in limestone rocks, Mr. Mackintosh contends that the above *smoothly* ground-out perforations (some of which run into and through fossils, and most of which ignore the composition of the rock) could not have been formed by rain, as nearly all of them occur in positions to which rain could never have had access.—Abridged from the *Ulverstone Advertiser* of Jan. 7, 1869.

GEOLOGICAL SOCIETY OF LONDON.—Various changes have taken place in the staff of this Society. 1. Mr. Henry M. Jenkins, F.G.S., who has for the past six years so ably filled the post of Assistant Secretary, has been appointed to the position of Secretary and Editor to the Royal Agricultural Society of England. Mr. W. S. Dallas, F.L.S., who, during the past ten years, has been the Curator to the Yorkshire Philosophical Society's Museum at York, has been elected to the post of Assistant Secretary, Librarian, and Curator in the room of Mr. Jenkins. 2. Mr. Skertchly, the Library Assistant, has resigned, in order to accompany Messrs. Bauerman and Lord to Egypt. Mr. Frederick Waterhouse, second son of G. R. Waterhouse, Esq., Keeper of the Geological Department, British Museum, has been elected in Mr. Skertchly's stead.



F.L.S. ad nat. lith W. West imp.

ania gracilis, Carr. Oolitic Shales of Yorkshire.
. Zamia muricata, Willd. 4. Macrozamia spiralis, Miq.

THE
GEOLOGICAL MAGAZINE.

No. LVII.—MARCH, 1869.

ORIGINAL ARTICLES.

I.—ON *BEANIA*, A NEW GENUS OF CYCADEAN FRUIT, FROM THE YORKSHIRE OOLITES.

By WM. CARRUTHERS, F.L.S., F.G.S., of the British Museum.

(PLATE IV.)

THE remarkable organs which are frequently associated with the *Zamia gigas* of Lindley and Hutton, and which have always been considered as in some way connected with the fructification of that plant, are the only fossils that can be referred to Cycadean fruits that have been hitherto observed in the Yorkshire Oolites, in which the remains of Cycadean leaves are so abundant. These organs have been made the subject of an elaborate memoir by Professor Williamson, presented to the Linnean Society some months since, and which it is to be hoped will soon appear in the Transactions of that Society. He has brought together so many observations, made during a life-acquaintance with these beds, that he has been able to re-construct, with every appearance of truth on his side, a singular genus, containing two well-marked species, and forming a new tribe of *Cycadeæ* very different from any living form.

Fruits closely related to those of the recent *Cycadeæ* have been found in Oolitic strata. Lindley and Hutton described, as a *Pinus*, a cone from the Inferior Oolite, which in a former communication to this Magazine (Vol IV. p. 101), I showed to be Cycadean, and named *Cycadeostrobus primævus*; and in the same paper I described a second species from the Oxford clay of Wiltshire, (*C. sphæricus*). I now add a third from Phillips's "Upper Shale" at Scarborough, which though agreeing in all essential points with the two species named, and with the living forms to which they are related, yet differs sufficiently to demand its being placed in a distinct genus. My colleague, Mr. Woodward, drew my attention to this interesting fruit, in that part of the Bean collection acquired some years since by the British Museum. It is not associated with any Cycadean remains on the small slab on which it occurs, so that there is no indication to which of the several leaf-species it belongs. I hope the publication of this notice, accompanied with Mr. Smith's admirable illustration, may bring to light other specimens that will supply this desirable information. A small fragment of *Acrostichites Williamsonis*, Brongn., occurs on the slab.

The diagnosis of the genus and species is as follows:—

Beania, gen. nov. Female fruit composed of scales arranged in loose spikes; scales stalked and peltate, supporting two ovoid sessile seeds, one on each side of the pedicel.

Beania gracilis, sp. nov. Axis of the female inflorescence slender; scales on slender stalks placed at right angles to the axis, peltate, apex of the scale small, scarcely covering the ripe seeds; seeds sessile, ovoid, slightly acuminate at the apex, symmetrically arranged on the two sides of the pedicel, reflexed.

Locality.—From the Oolitic Shale of Gristhorpe, near Scarborough, Yorkshire.

These characters show that this fossil belongs to that section of the order *Cycadeæ*, which was included in the Linnean genus *Zamia*. In the progress of discovery, this genus has gradually been broken up into nine distinct genera, arranged in two or more tribes (according to the views of different authors) based upon characters derived chiefly from the internal structure of the stem, but all agreeing in having the female fruits composed of two-seeded peltate scales arranged in cones. *Beania* agrees in every particular with the female strobilus of *Zamia*, as may be seen by comparing the fossil with the section of the cone of *Z. muricata*, Pl. IV., Fig. 3, except that the apices of the scales are not adpressed, but the scales are scattered over the axis so as to form a very loose spike. There is, however, a recent form, (*Microcycas*, D.C.,) which, according to De Candolle, in his lately published monograph of this Order in the Prodromus (Vol. xvi., sect. 2, p. 538), differs from the other genera in having the scales of the female cone "loosely juxtaposed." In *Beania* this character is still more pronounced, so as to produce an inflorescence, which cannot be called a strobilus.

A small and very imperfect fragment of *Beania* was figured by Lindley and Hutton on the same plate with their *Sphæreda paradoxa*, Fossil Flora, Plate 159. This fragment is of itself sufficient to show that it had nothing to do with *Sphæreda*, but it is obviously too imperfect to give any information as to its true affinities. There are no seeds preserved, and only three of the pedicels retain traces of their peltate apices. Dr. Lindley had not examined the specimens. He only prints the descriptions supplied by Dr. Murray and Mr. (now Prof.) Williamson, jun. Dr. Murray's description refers to the *Sphæreda*; and Prof. Williamson thus describes the specimen of *Beania* which was confounded with it—"The stems of the smaller specimens are striated, and the lateral branches appear to have been terminated by a kind of round or oval leaf, which is one homogeneous mass of carbon, without the least appearances of any regular veins or striæ either in the stems or leaves. The carbon is excessively thick, instead of being in thin laminæ as in most vegetable impressions." This description exactly agrees with what is seen in the specimen I have just described, and the explanation of those appearances, so anomalous to Prof. Williamson, is evident when the structure is properly understood, by the aid of the more perfect specimen now figured herewith.

I have sought to commemorate the successful labours of the late Mr. Bean in exploring the fossiliferous beds of the Yorkshire Oolites, by dedicating this genus to him.

EXPLANATION OF PLATE IV.

Fig. 1. *Beania gracilis*, sp. nov. From a specimen in the Bean Collection, British Museum.
Fig. 2. Young female cone of *Zamia muricata*, Willd.
Fig. 3. Section of the same, showing the young seeds attached to the scales. Being a longitudinal section only a single seed is seen connected with each scale.
Fig. 4. A single scale, with its two ripe seeds, of *Macrozamia spiralis*, Miq.
Figs. 1, 2, and 3 natural size. Fig. 4, two-thirds the natural size.

II.—GEOLOGICAL NOTES ON PARTS OF NORTHAMPTON- AND LINCOLN-SHIRES.

By J. MORRIS, F.G.S.

ALTHOUGH the geology of the Midland Counties has been considerably elucidated, still there appear to be some points connected with the position and nomenclature of the Lower Oolites which require re-examination.

Having long since published some observations upon this district,[1] in which the position of certain beds was somewhat doubtfully given, I am desirous to recall attention to the conclusions then arrived at by myself, as well as to others bearing upon the district subsequently published.[2]

The geologist who has personally examined the strata between the Upper Lias and Cornbrash, as they range between Gloucestershire and Yorkshire, or who may have become acquainted with them from the writings of Strickland, Hull, Lycett, and Wright, in the south-western area, and of Phillips, Williamson, Oppel, and Leckenby, in the northern, must be aware of the great lithological (and in part palæontological) differences which exist in the two districts, and would probably infer, that beds of an intermediate character might be found in the countries lying between them.[3]

In the south-western area the Lower Oolitic series attains its normal development both in formations and thickness, and presents a character almost entirely marine. This series consists mainly of limestones with intercalated sandstones, and clays, rich in Testacea, Corals, and Echinoderms, with occasional traces of land-plants in the Stonesfield slates of the Cotteswolds, which become more abundant in the similar beds of Oxfordshire, where they are associated with Reptiles, Fishes, and Terrestrial Mammalia.

The series attenuates rapidly as we proceed easterly, (as pointed out by Mr. Hull,) so that the Inferior Oolite, which attains a thickness of 250 feet at Leckhampton, is reduced at Stonesfield, near Oxford, to 15 feet. The Fullers Earth and Great Oolite are subject to similar variations. The former, as well as the Bradford clay, becoming thicker to the south, while the sands below the Inferior Oolite also vary in thickness in the same area.

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[1] See Brit. Assoc. Reports, 1847, p. 127, and Quart. Journ. Geol. Soc. 1853, Vol. ix., p. 317.

[2] See Memoirs Geol. Survey of Great Britain, 1860, Description of Sheet No. 53, S.E, and 1861, Description of Sheet, No. 53, N.E.

[3] See the interesting paper by Professor Phillips, "On some comparative sections in the Oolitic and Ironstone series of Yorkshire, Quart. Jour. Geol. Soc. Vol. xiv,—"Neither can the Bath type of the Oolites be adapted to the midland districts of England without some important changes." (P. 86). Also Geol. York. i. p. 130.

Professor Phillips has alluded to a similar variation in the Yorkshire area, "The great series of sandstones, shales, coal plants, and ironstones lying above the Lias and below the Oolite of Gristhorpe, 500 feet thick in the Peak and the great range of cliffs at Staintondale, is only 270 feet thick near Thirsk, and is further reduced near Bransby, until on the banks of the Derwent it is scarcely traceable." (*op. cit.* p. 97).

The whole thickness of the south-western formation, where fully developed, is upwards of 600 feet. The marine conditions and calcareous character of the strata in this area is strongly contrasted with that of Yorkshire, where the limestones are extremely thin, and are intercalated with sandstones, clays, ironstones, and shales, containing an abundance of land-plants such as Cycads, Ferns, and Coniferæ, with beds of "Moorland Coal" accompanied with *Unio* and *Estheria*: the whole series having a somewhat corresponding thickness of 600 to 700 feet. Thus the difference of condition in these two districts of deposition is well-marked by the abundance of organic and chemically-formed deposits (limestones) in the one area, and of inorganic or mechanically-formed deposits (shales and sandstones) in the other. Besides which, in the latter area, the geological sequence between the Lias and Cornbrash is not complete, for the associated thin limestones contain fossils from which it is inferred that the whole series should be classed with the Inferior Oolite, the equivalents of the Great Oolite, Bradford Clay, and Forest Marble being there wanting; this view is taken by Dr. Lycett,[1] and also by Dr Wright.[2] Dr. Oppel, however, whilst he includes the Lower Sandstone, Shale, and impure Limestone and underlying Dogger with the *Am. Murchisonæ* and *Am. Humphriesianus* zones of the Inferior Oolite,[3] appears to consider the Upper Sandstone and Shale as belonging to the Bath Oolite formation.[4] On the other hand, Dr. Oscar Fraas says, "In the north of England (Yorkshire), the lowercoal or moorland sandstone consist of a great local sandstone formation, with a large quantity of fragments of plants which is placed between 'the Inferior Oolite and the "Grey" Limestone of Phillips. But the Grey limestone of Yorkshire is merely what the Fuller's-earth of the south, the *Marnes à foulon* and the *Marnes vésuliennes* also are, the δ of the Swabian "Brown Jura."[5]

Professor Phillips, however, from the comparative sections given in the paper before alluded to, seems to be of opinion that the Oolite of Gristhorpe is the equivalent of the Bath Oolite, and that the overlying shales and sandstones represent an upper part of the same formation.

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[1] Pal. Soc. Suppl. to Gr. Ool. Mollusca, p. 115. The Cotteswold Hills, p. 74.

[2] Quart. Journ. Geol. Soc. 1859. D'Orb. Prodrome, 1850.

[3] Die Jura-Formation, p. 326, 333.

[4] Ibid, p. 439.

[5] Quart. Journ. Geol. Soc. vii. *Translations*, p. 60.

It is to some points in the Geology of the intermediate area that the following observations refer.

The Ferruginous Sand and Sand-rock, sometimes oolitic, of Northamptonshire, formerly referred to the Inferior Oolite, but subsequently called the "Northampton Sands," and referred to the Stonesfield Slate (Great Oolite), immediately overlies the Upper Lias Clay, and vary in thickness from 20 to 60 feet.

This rock, presenting nearly similar lithological characters, and occupying the *same* stratigraphical position, may be traced more or less continuously over the whole district through which the Nen and Welland flow. It is this rock which is now so largely explored in many localities of the district for the extraction of iron-ore. It presents, however, some well marked zones (especially near Northampton) which differ in the amount of iron they contain, as well as in the abundance of their fossil remains.

In the neighbourhood of Northampton this rock, reposing on the Lias, is overlain by Sand, Sandstones, and clay, containing fragmentary plant-remains, which are again covered by a considerable thickness of hard and soft limestones, rich in fossils, mostly belonging to the Great Oolite, as may be seen in tracing a section from the lower part of Northampton, in an ascending series, by Kingsthorpe, to the quarries on the Moulton-road, near to which a shaft was sunk, through the Lias, to a considerable depth, in search of Coal. A similar sequence is also seen in ascending from the Canal, near the Railway Station at Blisworth, to the quarries in the Oolite above the village, which, as on the opposite side of the valley, is covered by Drift clay. Amongst the fossils of the Red Rock may be enumerated:—*Tancredia axiniformis, Isocardia cordata, Trigonia* v— *costata, Quenstedtia laevigata? Hinnites velatus, H. abjectus, Ter. trilineata, Echinobrissus clunicularis, Hyboclypus agariciformis, Pygaster semisulcatus, Cardium Buckmanni, Pecten personatus, Ceromya Bajociana, Cypricardia acutangula,* D'Orb. *Macrodon Hirsonensis, Pecten demissus, P. personatus, Ostrea Marshii? Lima bellula, L. punctata, L. pectiniformis, Astarte elegans, Trigonia Phillipsi, T. costata, Pholadomya fidicula, P. Heraulti, Gresslya abducta, Chemnitzia vittata, Nerinæa cingenda, Am. bifrons? Am. corrugatus, Belemnites, Nautilus,* all of which are characteristic of the Inferior Oolite. Some of these fossils are found in the same rock at Cranford and Woodford near Thrapstone, and other localities in this district.

Thus it appears that this rock, so persistent in character and fossil contents over a large area, should be assigned to the position in which it was originally placed—as described in Conybeare and Phillips,[1] and later by Dr. Oscar Fraas,[2] who remarks, under his section "Lower Brown Jura," that, "to the north of Bath, Sandstones re-appear in part as great local formations, as at Northampton and Cheltenham, which are known as Inferior Oolite. These formations change from the coarsely Oolitic character, through all shades, to the finest sand, sometimes brown and ferruginous, sometimes white, with yellow bands (Arbury Hill). *Ammonites Murchisonæ* is certainly wanting, but *Pecten personatus*, *Clypeus sinuatus*, *Pholadomya obtusa*, and others are chiefly found."

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[1] Outlines of Geology, England and Wales, 1821, p. 218.

[2] On the Comparison of the German Jura with that of France and England. See Quart. Journ. Geol. Soc. vol. vii. 1851, *Translations*, p. 58.

Oppel refers these beds to the same period,[1] and Dr. Lycett[2] also.

In the Northampton area the White Oolites overlying the ferruginous bed do not appear to contain, in their lower beds, *many* forms of Mollusca belonging to the Inferior Oolite, as do those limestones to which we shall presently allude in the neighbourhood of Stamford. Species of *Astarte*, *Nerinæa*, and *Trigonia*, are found, and in the upper beds *Pholadomyæ* abundantly occur, frequently occupying the position in which they originally lived, as may be well seen in the quarries on the Moulton-road.

A somewhat similar arrangement of the same rocks may be found in ascending from the Wellingborough Station to Wollaston, where, however, beds equivalent to the Forest Marble occur, *Terebratula digona* being found in tolerable abundance, associated with other Great Oolite forms.

The next point for consideration is the position of the Collyweston Slates, which have been extensively worked in the neighbourhood of Stamford, since the time of Henry VII. Quarries may be seen at Wittering, Collyweston, Easton, Dene, and Kirby.

The geological position of these slaty rocks can therefore be clearly seen in many localities.

Thus, in the Valley of the Welland as of the Nen, the ferruginous Sand-rock before noticed overlies the Lias, and is covered by sand and concretionary calcareous Sandstones, which split horizontally after exposure, thus forming the so-called Collyweston Slates.

Overlying these are a series of cream-coloured marly limestones, as well as Oolitic rag-stones of some thickness, as seen in the quarries near Stamford, where they yield the so-called "Stamford marble," also at Barnack, Casterton, Geeston, Ketton, and Collyweston, whilst further west at Morcot, similar compact limestones overlie slaty rock containing *Lingula*. It is these Lower Limestones which contain a series or group of Mollusca, which are considered in part to be characteristic of the Inferior Oolite, associated with similar species of Cycads and Ferns (*Pecopteris polypodioides*), as occur in the Oolitic shales of Yorkshire, whilst the Upper White Limestones include a fauna in which those forms are more rare.

In some quarries, as near Ketton, a line of separation is marked in the Oolitic rocks by definite perforations caused by *Lithodomi*, which clearly indicate a period of arrested deposition in this old seabed, during which these mollusks lived and inhabited the surface of the subjacent rock, already partly consolidated.

It is above these upper beds that the laminated Clays and Shales containing plants, with one or two species of *Cyrena*, showing their probable fluvio-marine condition, occur, as seen at Ketton and

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[1] See Die Jura-Formationen, 1856–58, p. 357.

[2] The Cotteswold Hills, p. 73.

Casterton, near Stamford, and in the Essendine and Danes Hill Cutting of the Great Northern Railway.[1]

The similarity in position of the ferruginous rock, between the Lias and White Oolites, is seen in the Spittlegate Cutting, and to the south of it at Ponton, in the same railway; also in the neighbourhood of Lincoln, where the Lias, which occurs in the Valley of the Witham, is overlain by the ferruginous bed, which, in its turn, is covered by compact white Oolitic limestones, yielding durable stone for building purposes[2] (the "Silver-bed" and Roestone-bed), and containing Mollusca of Inferior Oolite age, as *Ceromya Bajociana* and other species.

Further north, as well known to Professor Phillips, the ferruginous beds at Brough, on the Humber, containing numerous *Rhynchonella spinosa*, and other shells, are followed in that area by beds known as the Cave Oolite, which is the equivalent of the limestones of Whitwell and Weston.

Fossils of the Lower White Limestones of Morcot, Stamford, Denton, etc.:

Natica cincta, Phil. *Nerinæa cingenda*, Phil. *N. triplicata*, Br. *Lucina Wrightii*, Op. *L. despecta*, Phil. *Ceromya Bajociana*, D'Orb. *Pholadomya fidicula*, Sow. *Hinnites abjectus*, Phil. *Gervillia Hartmanni?* = *G. radians*, Lyc. *Lima Pontonis*, Lyc. *L. bellula*, Lyc. *L. cardiiformis*, Sow. *Macrodon Hirsonensis*, D'Arch. *Trigonia Phillipsi*, Lyc. *T. hemispherica*, Lyc. *Tancredia axiniformis*, Phil. *Inoceramus obliquus*, Lyc. *Astarte elegans*, Sow. *A. minima*, Phil. *Pecten pumilus*, Lam. *Cucullæa cancellata*, Phil. *Ostrea sulcifera*, Phil. *Goniomya* v— *scripta*, Sow.—*Pygaster semisulcatus*, Phil. *Hyboclypus agariciformis*, Forbes. *Stomechinus germinans*, Phil. *Echinus perlatus*, Desm. *Pseudodiadema depressum*, Ag. *Echinopsis rotata*.—*Pecopteris polypodioides*, *Pterophyllum comptum*, *Palæozamia pecten*.

Fossils of the Collyweston Slates:

Pecten pumilus, Lam. (*P. personatus*, Ziet.) *Avicula elegans*, Munst. *A. Braamburiensis*, Phil. *Hinnites velatus*, Goldf. *Gervillia acuta*, Sow. *Pinna cuneata*, Sow. *Modiola Sowerbyana*, D'Orb. *Astarte excavata*, Sow. *Trigonia costata*, Sow. *T. compta*, Lyc. *Cucullæa cancellata*, Ph. *Pholadomya fidicula*, Sow. *Ceromya Bajociana*, D'Orb. *Cardium Buckmani*, Lyc.? *Lucina Wrightii*, Op. *Goniomya literata*, Sow. *Homomya crassiuscula*, Lyc.? *Lingula Beanii*, Phil. *Perna rugosa*, Goldf.—*Pterocera Bentleyi*, Lyc. *Alaria Phillipsi*, D'Orb.

Brief and imperfect as is this notice, I think that the facts previously stated suggest that the position of certain parts of the Lower Oolites should be reconsidered, and that attention should be drawn to the following points.

1. That the red or ferruginous rock, immediately overlying the Lias, and extending over the district watered by the Nen and the

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[1] Morris, Quart. Journ. Geol. Soc, ix. p. 330.

[2] W. Bedford, Account of the Strata of Lincoln, Mag. Nat. Hist. 1839, p. 663. The Cathedral is built of the "silver-bed" and of the beds below it; the Roestone was used for the construction of Newport Arch, built by the Romans.

Welland, belong, by its fossils, to the Inferior Oolite, and, probably, represents in time part of the "Dogger beds" of Yorkshire.

2. That the Sands and concretionary calcareous Sandstones known as the Collyweston and Wittering slates, as well as a part, if not all, of the overlying Oolite (Ponton, Corby, Stamford, Barnack, Morcot,) also belong, by their fossils, to a higher zone of the Inferior Oolite, and may be the equivalent in time of the beds overlying the Dogger.

3. That the Upper White Limestones and Shales, over certain parts of the area of Northamptonshire, are the representatives of the Great Oolite.

4. That in the Upper and Lower Oolites of Lincolnshire, above the red rock, there are very few *Cephalopoda*, and that the lower zone is marked by the prevalence of *Nerinæa, Astarte, Tancredia, Quenstedtia, Trigonia, Cardium, Cucullæa, Alaria*, and a large *Natica*, associated with fragments of *Pterophyllum* and other Cycads, and *Pecopteris polypodiodes*, a species largely represented in the Oolitic Shales of Yorkshire. They have been placed provisionally upon the horizon of the Great Oolite, but their fauna would seem rather to connect them with the *Inferior Oolite*,[1] Lycett.

5. That from the general fossil contents of these beds, they present characters intermediate to the more truly marine conditions of the south-western or Gloucestershire area, and the Fluvio-marine and Terrestial deposits of Yorkshire.

6. That the Collyweston slates contain chiefly a molluscan facies, while those at Stonesfield comprise a rich and varied fauna of shells, crustacea, insects, fishes, reptiles, mammals, and many plants.

The following are some of the localities where sections may be observed and fossils obtained, in illustration of the preceding remarks:—

1st. *Southern Area.*—Pits around Blisworth, where the Lias, Red Rock, and Oolites may be seen.

The quarries around Northampton, and northwards at Kingsthorpe, Moulton Road, and at Duston, beyond Dallington.

The pits around Wollaston where the Upper Oolite with *T. digona* may be seen.

Higham Ferrars, Raunds, Stanwick, and Oundle, (where *Ophioderma Griesbachii* was found.

The sections near Wellingboro', Kettering, Finedon, etc.

The quarries around Wansford, where Dr. Fitton mentions that the fern referred by Lindley and Hutton to *Lonchopteris Mantelli*, was found, from which it was inferred that traces of the Wealden occurred in Northampton.[2]

2. *Northern Area.*—The pits around Stamford, Casterton, and Ketton. The quarries at Collyweston and Easton, and further west at Morcot and Luffenham.

Unfortunately the collection made by me, which would have afforded incontrovertible palæontological evidence of the beds in this district, is now in great measure dispersed, but the re-consideration of the sections made at that time in traversing the district, suggest the position assigned in this paper to the ferruginous Oolite and the Collyweston slates.

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[1] See a paper by Mr. Horton in the Geologist, vol. iii, p. 249.

[2] Fitton, Geol. Trans., vol. iv. p. 309, but corrected at p. 383*, and also in Geol. Jour., vol. xi. p. 337.

Some of these observations, which I now recall with so much pleasure, were made in company with Captain L. L. B. Ibbetson, F.G.S., Mr. J. Bentley, Mr. Samuel Sharp, F.S.A., F.G.S.,[1] M. Trigér, and the late Dr. Oppel, who has embodied part of his observations in his great work on the Jura formation.

III.—ON THE RELATIONS BETWEEN THE SKIDDAW SLATES AND THE GREEN SLATES AND PORPHYRIES OF THE LAKE-DISTRICT.

By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S.

THE Skiddaw Slates, or Lowest Silurian Rocks of the Lake-district, are succeeded upwards by a great series of ashes with interbedded traps and porphyries, to which the name of "Green Slates and Porphyries" has been applied, and it has always been believed that the relations between the two were those of perfect conformity. As early, however, as the year 1867 I was led, from certain phenomena which I had observed, to express the opinion that "whether the Green Slates are really conformable with the Skiddaw Slates is a question which admits of doubt, though data are wanting to arrive at a definite conclusion." (Geology of Cumberland and Westmoreland, p. 33.) In the beginning of November, 1868, I discovered what seemed to be a marked want of conformity between the Skiddaw Slates and the Green Slates, the localities where this occurred being the eastern side of the mouth of the vale of St. John, the west side of Derwentwater (near Lowdore), and the mouth of Borrowdale. As these phenomena had not been previously noticed by any former observer, and as they appeared to me to be of considerable importance, I have made a systematic investigation of the subject, and have arrived at the following results.

Beginning with the main area of the Skiddaw Slates, in the north-western portion of the Lake-district, the upward boundary of the slates can be traced to the south of the area from Troutbeck on the north-east to near Egremont on the north-west, a distance of more than twenty-five miles. Along this line the relations between the Skiddaw Slates and the overlying Green Slates are as follows:

In the course of Troutbeck Beck, close to the little village of Troutbeck, the upper, soft, and shaly beds of the Skiddaw Slates are seen on the western side of the stream, dipping S.S.E. at 65°. These are overlaid in the eastern bank of the river, by the basement beds of the Green Slate Series, consisting here of cleaved felspathic ashes, dipping S.S.E. at 50°. About three-quarters of a mile further up the river the upper bed of the Skiddaw Slates are again seen, dipping S.S.E. at 55°, and shortly succeeded by a felspathic trap, the inclination of which could not be determined. Proceeding westwards, no sections are obtainable till Mosedale Beck is reached at a distance of about a mile and a half. Here the shaly, upper beds of the Skiddaw Slates are seen just below the road from Matterdale to Threlkeld, dipping N.N.E. at 55°; and surmounted by the massive trap which forms Wolf Crags. For a short distance to the west of Mosedale Beck the Skiddaw Slates are separated from the lowest trap of the Green Slates by a boss of intrusive felstone derived from the syenite of the vale of St. John. The two shortly come together again, and are seen in a ravine in one of the eastern spurs of Clough Head, where the dip of the Skiddaw Slates is from 45° to 60° to the S.S.E. All along the flanks of Clough Head the upper beds of the Skiddaw Slates can be traced at a considerable elevation, and overlaid by the felspathic trap before-mentioned. In many places they are a good deal disturbed, and are often indurated and penetrated by small veins of quartz, but the dip is mostly to the S.S.E. at angles of from 30° to 50°. In the ravine which leads from Threlkeld Common to Lowthwaite in the vale of St. John, the Skiddaw Slates are seen near the top of the ascent, dipping S.S.E. at 55°. They appear to be continued underneath Wanthwaite Crag, nearly as far as Lowthwaite, the same felspathic trap appearing to rest upon their upturned edges for the whole distance; but this is perhaps due to faulting, as the country is a good deal disturbed, and there is no clear section.

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[1] It is interesting to record that Mr. Sharp has, during many years, collected largely both in the neighbourhood of Stamford and Northampton from these beds, and has thus enlarged our knowledge of the Oolitic fauna of this district.

On the opposite side of the vale of St. John (*i.e.*, the western side), an intrusive syenite intervenes between the Skiddaw Slates and Green Slates. There is still, however, evidence of a want of conformity. Thus all along the flanks of Naddle Fell a succession of bedded traps and greenstones, with intercalated thin bands of ashes, is exceedingly well displayed, forming a series of oblique terraces, which dip S.S.E. at about 30°. The angle of dip, therefore, of the lower part of the Green Slate Series is very markedly lower than the dip of the Skiddaw Slates on the opposite side of the valley, and indeed in almost all localities, since this is usually between 45° and 65°. The same low inclination of the Green Slate Series is equally well exhibited in the parallel valley of Naddle Beck, in the northern end of Castlerigg Fell. Between the vale of St. John, however, and the town of Keswick, the upward termination of the Skiddaw Slates is not seen, as the country is thickly covered with drift.

In the bed of the Greta, in Keswick, the Skiddaw Slates are seen dipping southward at high angles, and succeeded to the south by the greenstone of Castle Head, a little wooded hill close to the town. On the western side of Derwentwater the junction between the two formations can be traced about half a mile to the south of Portingscale. Thus the wooded hill, called Fawe Park, is composed of the upper beds of the Skiddaw Slates, dipping S.S.E. at from 40° to 50°. These are succeeded at Rosetrees by a felspathic trap, immediately succeeded to the south by the Skiddaw Slates again. The trap can be traced along the strike for some two or three hundred yards, but no trace of it appears on the side of Swinside, a little to the west of Rosetrees. These phenomena are caused by the existence of an enormous E.N.E., and W.S.W. fault, whereby almost the whole—if not the whole—of the Skiddaw Slates are repeated to the south of this point. The existence of this fault was determined by me in November, 1868, and I made out at that time that the upper boundary of the Skiddaw Slates, instead of running, as formerly supposed, up the vale of Newlands to the foot of Buttermere, was really to be found some three miles to the south of this line, passing by Lowdore, High Lowdore, Grange, and the Hollows, in a south-west direction towards the head of Buttermere. These facts will be rendered easily intelligible by the accompanying section.[1]

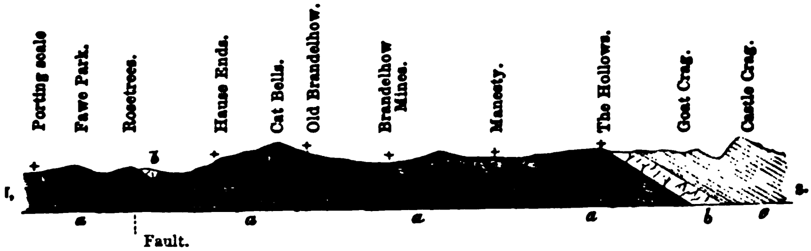

Fig. 1. Section from Portingscale, along the west side of Derwentwater, to Castle Crag in Borrowdale. Length of section five miles.
a. Skiddaw Slates.
b. Felspathic trap, forming the base of the Green Slate Series.
c. Cleaved Breccias and felspathic ashes (Green Slates).

Proceeding now to the east side of Derwentwater, the Skiddaw Slates are seen at various points between Lowdore and Grange. They form the lower portion of the ledge over which Watendlath Beck falls to form the celebrated cascade of Lowdore, the upper portion of the ledge being formed by the felspathic trap, which constitutes the base of the Green Slates. They are well exhibited, also, in a field about half way between High Lowdore and the village of Grange. They possess here all their usual character, and dip E.S.E. at 60°. They form a number of ice-worn bosses on both sides of the road, and they are immediately succeeded by a felspathic trap of a dark-green colour, compact, and fine-grained, which forms the northern end of Grange Fell. The dip of this trap could not be accurately determined, but its apparent inclination is small. Crossing to the western side of the valley of Borrowdale, the junction between the Skiddaw Slates and the Green Slate Series is very well seen near a farmhouse called the Hollows, about three-quarters of a mile south of Manesty. Here the Skiddaw Slates are seen dipping S.S.E. at 50°, and are surmounted by the same felspathic trap, seen near Grange. There is no apparent disturbance of the strata at the line of contact, but the beds immediately beneath the trap are of a light greyish brown colour, and do not present the ordinary appearance of Skiddaw Slate. This lowest trap is overlain by a great series of cleaved felspathic ashes and breccias, the whole, when seen on a large scale, dipping S.S.E. at a low angle (probably about 25° to 30°). These ashes and breccias have been largely worked for slate in Goat Crag and Castle Crag, and in the neighbourhood of the Bowder Stone. The dip of the cleavage does not differ from that of the bedding, except in amount, and is S.S.E. at from 80° to 90°.

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[1] The further continuation of the Newland's Valley fault to the east is stopped by a north and south fault which must occupy the line of Borrowdale and Derwentwater. Westwards it appears to be cut off by the great mass of intrusive felstone-porphyry which forms the group of mountains between Buttermere and Ennerdale, and of which Red Pike, High Stile, and High Crag, are amongst the more striking elevations.

Two points are observable here, one regarding the stratigraphical position of the highest beds of the Skiddaw Slates which are seen in this section, the other relating to the composition of the breccias in the Green Slates. As regards the first, the beds upon which the lowest trap rests are not by any means so soft and shaly as are the upper beds of the Skiddaw Slates. They much more resemble the lower beds, being usually hard and flaggy, and this continues to be the case as far as Honister Crag. I shall, however, afterwards adduce instances in which the lowest beds of the Green Slates are more conspicuously and unequivocally superimposed upon the *inferior* portion of the Skiddaw Slates. As regards the second point, I would merely observe that very many of the included fragments of the breccias in the Green Slates—both in this and in many other localities—are extremely similar to pieces of Skiddaw Slate.

From the Hollows the line of junction between the Skiddaw Slates and Green Slates can be traced across Low Scawdel to Castle Nook, beneath Eel Crags, a little to the north of Dale Head, and through the north-western end of Honister Crag. Along the whole of this line the Skiddaw Slates dip S.S.E. at angles of from 50° to 65°, and they are uniformly surmounted by the felspathic trap, which is ordinarily at the base of the Green Slate Series. In the Gatescarth valley, on both sides, these phenomena are especially well exhibited. Thus, under Dale Head, the highest beds of the Skiddaw Slates, as seen in this section, dip S.E. at 75°, and are directly overlaid by the same felspathic trap with overlying slates and breccias, which we have already found to exist at the entrance of Borrowdale, the dip of the latter not appearing to exceed some 30°, or thereabouts. Exactly the same thing can be seen in the flanks of Honister Crag, the dip of the Green Slate Series being particularly well displayed here, especially when viewed from the opposite side of the valley.

(*To be continued*).

IV.—SUGGESTIONS ABOUT DENUDATION.

By G. HENRY KINAHAN, M.R.I.A., F.R.G.S.I., etc.

DENUDATION has been divided into only two kinds—viz., *Subærial* and *Marine*; nevertheless, naturally there seem to be three marked denuding forces—I. *Subærial* or *Atmospheric*; II. *Marine*; and, III. *Glacial.*[1]

Marine denudation has so often been described, and by such competent writers, that little has to be said about it. However, it may be mentioned that it seems rarely, if at all, to act except on shore lines, and in such places generally above low-water-mark. Some writers seem to consider that its normal work is to cut "Marine plains;" nevertheless, this seems to be the exception, not the rule. It might possibly happen, if the sea was acting on a homogeneous rock, but when it is considered that rocks in general are rarely homogeneous or, as is often the case, many different varieties are interstratified, it is not surprising that off so many coasts are islands and sea-rocks. These are the remains of compact portions of a rock or tracts of rock or hard beds which the sea in its advance left on account of their firm nature, while it carried away their frail associates. Chalk apparently ought to be one of the most homogeneous substances in nature; and if marine action usually planes the ground evenly away, in Chalk it might be expected to cut a "marine plain." Nevertheless, the coast-line of a Chalk country is usually irregular, and lying off it are islands and rocks. If the sea acts on horizontal or nearly horizontal strata, naturally it should cut a plain, except where dykes of intrusive or other rocks occur, when portions of the horizontal strata may be protected and thus form islands, which subsequently, after the land rose, would appear as hills. When the sea has retreated and a plain is left, may not this be as much due to atmospheric as marine denudation? for rain and rivers supply the materials to fill up the irregularities in the sea-bottom.

Glacial denudation, seemingly, ought to be considered a different action to *Subærial* (Chemico-fluvial), as these two forces work so differently. A glacier has been said to belong to the chemico-fluvial agencies, as "it is only a frozen river;" but compare the work a glacier and its tributaries can do with that of a river and its tributaries. The tributaries of the first are beds of snow and ice, while those of the latter are all the chemico-fluvial forces combined; the glacier and its tributaries works altogether by mechanical action, being confined to planing and triturating rock, except when it does a little quarrying by tearing off masses of rock; while the chemico-fluvial denudation is due to chemical and mechanical action combined, moreover, the latter is quite different to that exercised by ice, for it is principally carrying away materials loosened by chemical action; the only trituration it accomplishes being that done in river-rapids and mountain torrents; but it does not appear capable of planing down a rock; and ice, as icebergs, may possibly be able to denude the sea bottom on which none of the other forces can act. Many rocks, such as dolerite, diorite, diabase, granite, some limestones, etc., are physically hard, while they are chemically soft; others, such as slates, schists, clays, etc., are physically soft while they are very little susceptible of chemical decomposition. The former, therefore, are easily denuded by the chemico-fluvial agents, and the latter resist them; also while a planing action, such as that exercised by ice, would be resisted by physically hard rocks, it could easily excavate and cut away the soft ones; and are not these the results found in nature? In an ice—"dressed, planed, and and etched"—country, all the physically hard rocks have formed features from a few feet in height to hundreds or more; but since the ice has disappeared the chemical agencies have had their sway, and these rocks are now weathering fast; while the chemically hard but physically soft rocks—those that under the old regime suffered most—are now almost perfectly unmolested.

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[1] Although *subærial* or *atmospheric denudation* are the received names for the first class of denudation, yet neither seems unobjectionable; for, strictly speaking, *all denudation is subærial* and *all is caused by atmospheric influences*, as all mechanical denudation, without these influences, would be *nil*. Difference of temperature causes the wind, the oceanic currents, and the glaciers, also the evaporation that eventually forms the rain and rivers. When it is said "Ice is one of the subærial agents," the statement is quite correct; but if "Subærialists" claim its action, they ought also to claim marine denudation; for, without the atmospheric influences, there would be no oceanic currents, no tidal currents, no storms—in fact, no denuding action at all. On the other hand, "Marinists" might claim all work done by rain and rivers, as they were originally sea water, which, previous to leaving, had taken "a return ticket" to go by the atmospheric way and come back by the river.

In the first of the above divisions (Subærial or Atmospheric denudation) is included *all the work done by the chemical action of the atmosphere and the mechanical work by rain and rivers*. This seems to have been the original doctrine of the "Subærialists," although of late they would wish to include all glacial work. Seemingly a less objectionable name than either Subærial or Atmospheric would be *chemical denudation*, but, perhaps, a better still would be *Chemico-fluvial denudation*, as this latter term would include not only the chemical action due to Atmospheric influences, but also the mechanical work done by rain and rivers.

It has been stated "that glaciers can do very little work in excavating their valleys." This may, possibly, be the case; but if we look at the rivers always flowing from them—ever turbid and white with the silt formed by the trituration of the blocks and fragments of rock in the ice grinding against one another, and the sides and bottoms of the valleys—we may be excused for not putting implicit faith in the assertion.[1] Moreover, this work is never ending from one year's beginning to another year's beginning, as long as the glacier lasts; while fluvial action only exists in full force during part of the year; however, it must be allowed its accomplice, chemical action, is always at work.

The chemico-fluvial agents are undoubtedly the most universal performers in the great work of denudation, as they are auxiliaries to the other two, and, when combined, the work done is enormous; but individually no one force seemingly can do much work. With the glacier they combine, in the shape of wind, frost, etc., and quarry the blocks in cliffs and steep mountain sides, from which they topple down on to the glaciers, afterwards to be swallowed up in *crevasses*, and act as tools to triturate, plane, and carve the sides and bottom of the valleys—they also materially assist the marine denudation, loosening the cliffs and land, preparing them for carriage away by the sea. Nevertheless, here the sea, in some way or another, co-operates with the chemical action, for many, if not all rocks at the sea weather more freely than elsewhere.[1]

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[1] Hayes says "The ice was perfectly pure and transparent" (of "Tyndall glacier"), "and yet out of its very heart was pouring the muddy stream of which I have made mention."—"The Open Polar Sea." p. 436.

The chemical action is not merely a surface-worker, for its influence can be found at a considerable distance below the surface; but some "Subærialists" would wish it to be believed that the chemico-fluvial agencies can do nearly all the work of denudation, while others would give them much greater power than they possess. It has been stated that the parallel valley terraces, such as those described by Dr. Hooker in the valleys of the Himalayas, are due solely to chemico-fluvial agencies, they having been cut in alluvium, which accumulated in flats behind barriers across valleys; and as the barriers were cut down by the fluvial action, the terraces were formed. This theory at first seems very plausible, but on consideration it will be asked: What formed the barrier? and is the drift behind it always alluvial? To the first it may be answered, "Certainly not chemico-fluvial agencies, as they have no power to scoop out rocks behind a barrier;" and to the second, "Certainly not." Marine action might possibly have formed them, as we know that the sea, going in or out of a long bay or fiord, leaves bars in the narrows, while it cuts deeps above them; however, as those barriers now under consideration are in mountain valleys and in the vicinity of glaciers, and as it is known that ice can scoop out rocks—Is it not more natural to suppose that these barriers are the result of glacial work? The chemico-fluvial agents, if they are given time enough, can cut through any barrier, but this will be a work of time and most gradually; and a gradual lowering of the water above the barrier will not form a cliff but a slope. To form a series of alluvial flats, and to cut in them a series of steps, necessitates a sequence of periods of rest, while the flats were being formed, and of denudation for the steps to be cut, which is quite opposed to any theory of gradual chemico-fluvial denudation. In the Himalayas, however, the formation of the terraces is easily explained, for Dr. Hooker mentions the torrents or debacles of mud and boulders that suddenly come down the slopes of the hills and "dam up more than half a mile of the course of the river into a deep lake." A series of these debacles will account for any number of parallel sets of terraces. It may now be stated that still they are due to chemico-fluvial agencies, as the mud torrents were caused by those powers. This is unquestionable; but at the same time it may be pointed out that they had as an auxiliary, glacial action: for it was the breaking up of the glaciers which caused the debacles.[2]

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[1] See short notes on this subject by the writer, GEOL. MAG. Vol. V. p. 18.

[2] Capt. Forbes, R.N., in "Iceland, Its Volcanos, etc.," pp. 281, *et sequit.* mentions huge debacles caused by glaciers being loosened and displaced by volcanic heat.

Other extreme subærialists would make their favourite agencies do an enormous quantity of work; and to prove these theories they base their calculations on the fallacy: "That all the surface of the ground is being more or less denuded." This, however, is contrary to facts. In tropical regions there must be an enormous amount of denudation, as the hot winds and sun parch up the surface, forming great thicknesses of debris, to be carried away by the torrents during the subsequent rains. Still, even in those climes, denudation does not affect the whole area, as miles are covered with jungle and forest, sure protectors of the surface. In alpine and arctic regions the everlasting snow and ice act in a similar manner, and it is questionable if in the temperate regions, the chemico-fluvial agencies are able to gradually denude even half the surface exposed: for in damp districts undoubtedly *they naturally would act more as preservers than destroyers.* This is well exemplified in many mountainous mining districts; for in such localities fuel is often scarce, and the miners cut for firing all the peaty surface soil that clothed the mountain and preserved it from denudation; consequently the rain and other agencies act upon it for a season, cutting the surface into small ridges and hollows. Nevertheless this does not last long, as the dampness of the climate soon clothes it afresh with a peaty garment, and thereby effectually preserves it. In a district miners have occupied for a considerable time, all the different stages can be observed. The places from which turf has not yet been cut, where there has been no denudation; the newly turf-bereft spots, where denudation is at work; and the older turf bogs where the mountain is again covered with a thin coat of peat.

A group of table-topped hills, capped by peat and bounded by steep escarpments, are good illustrations, showing the contrast between the destroying and preserving powers of the chemico-fluvial agencies. First the original mass, by denudation of some kind or another, would seem to have been planed into a flowing gradually undulating table land with gently sloping sides. Subsequently, by one or other of the kinds of denudation, or what is more probable, by two or more combined, valleys and ravines were cut transversing the table land in various directions, and forming the individual hills. When the chemico-fluvial agencies began to work, or a short time afterwards, peat must have begun to grow on the hill tops which effectually prevented them from being denuded, therefore those powers could only act in the valleys and ravines, on the sides of which they formed steep slopes, crowned by perpendicular escarpments usually a few feet higher than the thickness of the envelope of peat. The thickness under the peat is generally the remains of the original surface drift of the ancient undulating table land, and as the covering of peat now protects its surface, the chemico-fluvial agents work in sideways, undermining the peat, which consequently topples over in large pieces when its weight overcomes its tenacity. Thus, as the waste is proceeding both vertically and horizontally, the area of the flat summits must decrease, although most slowly. Favourable circumstances will much accelerate this horizontal denudation, such as in some districts continuous and prevalent winds from certain points of the compass, these rapidly undermine the peat, consequently on such sides of the hills the slopes are much more gradual than on those sheltered from the wind, where the chemico-fluvial agencies have, unaided, to work in under the peat.

In cultivated districts, where the valleys are inhabited and tilled, the protected area of the whole surface must gradually diminish; for, as the valleys widen, the quantity of tillage is increased. But in wild districts, where nature still reigns, what is taken from the protected summit, has an equivalent returned in the valleys; for when the latter have become wide enough, there peat also forms, which, once it has established itself, rapidly grows not only on the flat, but also creeps up the slopes; so that eventually there is only a small fringe round the edge of the table-topped summit which can be acted on by the denuding forces.

In moist climates, not only on mountains, but also on low lands, (if uncultivated,) unless drained naturally or artificially, peat will grow and defy denudation. Even in cultivated tracts, when the land is under grass and not in tillage, denudation can have very little effect. This is well illustrated when a section is opened down a hill-slope that has for a long time been grass land, more especially if it merges at the bottom into a boggy flat. In this instance it will be found that there is scarcely any difference between the thickness of the surface soil at the summit and base of the hill, while the peat from the flat has been gradually encroaching on the grass land and creeping up the hill. On the other hand, if a section is cut down a similarly circumstanced hill, except that it has been tilled for a considerable time, the results will be different, and the denudation quite apparent: for the surface soil will be much reduced in thickness on the slope and summit, it being carried down the hill and even found overlapping and lying on the peat in the flat below. Such a section will also give a record of the number of times and periods the hill has been in tillage and under grass; for the peat and surface soil at the base of the slope will be found interlaced according to the number and length of times the hill was exposed to the denuding influences. It may be said, that although the chemico-fluvial agencies do not denude the surface of the grass land, yet the water percolating through the soil increases its depth by gradually rotting the subsoil. This also, seems to be disproved, as it is not of uncommon occurrence when draining grass land, that formerly was tilled, to find lying on the surface of the subsoil the old sods, and this could not be the case if the atmospheric influences had the power of increasing the depth of the surface soil in grass land. Against the protecting power of grass land, it may be put forward that in many places "stones grow on the surface," or, in other words, that the surface of some grass land gradually becomes covered with stones. This cannot be controverted; however, it is only an exception to the general rule, and in moist climes *can never occur except in places that naturally are subjected to extreme drainage;* such as Chalk hills, or a country over the cavernous parts of the Carboniferous or other limestones; and on the former flints will collect, while on lands over limestone, pieces of chert or other hard substances. The calcareous class of rocks, as they are in a great measure chemically formed, seems to be more susceptible than other rocks, and succumbs easily to the chemico-fluvial agencies, the carbonate of lime being carried off in solution, while the insoluble substances, such as flint, chert and clayey matter remain. Besides, during part of nearly every summer, such lands will be scorched and burned by the sun forming part of the decomposed rock (the surface soil) into dust, and leaving it ready to be carried away by the first wind or rain; but grass land over clays, shales, slates, igneous rocks, and most sandstones, will not "grow stones."

Engineers are well aware of the protecting power of grass, and they grow it on the slopes of their railway cuttings and embankments, by which means all denudation is stopped in two or three years; after which the surface is gradually added to. The latter fact is patent to any one who will "look and learn;" for the platelayers while repairing the permanent way always throw some of the old bolts, chairs, or rails on the grass slopes, and if a bolt is left there for a year it will be half covered, while after a few more years it will be completely grown over; for the chairs to disappear it will take five or more years, and the rails proportionally more.[1] It may be stated that the covering up of these foreign substances is due to particles of soil carried down the slopes. This, in a few exceptional places may be the case, but in most instances it is due to the *bonâ fide* growth of the grass, and it will occur not only on the slopes, but also on flat level waste pieces of ground alongside railways, where such substances are also thrown. It should be mentioned that the growth of grass on railway slopes is unnatural, as previous to sowing grass seed it is necessary to "soil the slopes," *i.e.* put a coat of vegetable soil on them. Naturally new exposures of drift, or even alluvium, take years before plants vegetate properly on them; as will be seen in railways where the slopes are not "soiled;" on slob lands reclaimed from the sea, or a drained lake bottom, etc. In all these places, if uncultivated, it will take years before a natural protecting coat of grass will grow. This, apparently, is due to the new soil being incapable of supporting vegetation until the surface is partly decomposed by the atmospheric influences, and this action usually goes on, extremely slowly at first, until plants begin to grow; afterwards it seems to be accelerated by the vegetation, and gradually to increase year after year; and eventually all denudation must cease when the vegetable clothing is matured. According to the nature of the soil, the atmospheric influences will have acted to a greater or less depth; for if it be a stiff clay, they will not make more than three or four inches of vegetable soil before the denudation ceases, while in friable alluvium they will have penetrated to twice or three times that depth.

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[1] The disappearance of stones, etc., needs no *growth* of soil. It has been explained by Darwin "On formation of mould," Trans. Geol. Soc.—[ED. GEOL. MAG.]

The effect of stopping all vegetation and allowing chemico-fluvial denudation to exert its full powers, is well exemplified in the neighbourhood of Swansea, where the fumes from the copper ore smelting furnaces have changed fruitful fields into a desert, allowing this denudation to act in full force; and other localities could also be enumerated where its effects may also be traced since the protecting vegetation has been removed.

V.—On the Basalt of South Staffordshire.

By Samuel Allport, F.G.S.

As several papers by Mr. David Forbes and Mr. Sorby have probably by this time induced a few Geologists to turn their attention to the importance of a microscopical examination of rocks and minerals, it may interest some of your readers to know that the application of this method of research has just lead to a rather interesting discovery.

During the last four years I have made several hundred sections of igneous and metamorphic rocks (chiefly British), and among them a considerable number of the Basalt of the South Staffordshire coal-field. This rock is a Dolerite composed mainly of a triclinic felspar, probably Labradorite, Augite and Titano-ferrite. It also frequently contains two green minerals, one with a definite crystalline form, the other in streaks, or irregular patches, and occasionally filling cavities; the latter has every appearance of being a secondary formation, and may be Delessite. In addition to the above, I have found nine or ten other minerals which I will not now stop to enumerate.

The first discovery due to the microscope was the detection of *Olivine.* Having observed two small crystals in one of my sections which were evidently different from any of the other minerals, I examined them with polarised light, and found that they presented precisely the same appearances as those seen in sections of Olivine which I had previously made. After many visits to the quarries in search of larger specimens of the mineral, I succeeded in finding it in sufficiently large grains to be easily recognized.

The green mineral with the crystalline-form above mentioned remained to be determined. It was evident, in the first place, from its action on polarised light that it was a pseudomorph, the appearance of such an aggregate of mineral matter being very different from that of a single uniform crystal; and, after making more than thirty sections, the last two have enabled me to arrive at the conclusion that the mineral in question is a pseudomorph after Olivine.

The two sections contain many crystals of this mineral in various stages of alteration, from the first commencement to the completion of the process. The change began either at the surface, or along the line of cracks running through the crystal; in the latter case, the transformation extended from both sides of the fissure, forming a narrow, or wide green band, according as the process continued or not. Where several cracks existed, the green bands soon united, and the entire crystal was changed. In another instance the change commenced at the surface and extended inwards, till only the central portion was left unaltered; or again, the change proceeded in both ways simultaneously.

The evidence afforded by the study of these sections is so complete, that there cannot, I think, be a doubt as to the conclusion to be drawn. The rock-specimen is from Hailstone Hill, and is a well-crystallized, nearly black, basalt, of rather coarser grain than the mass of the rock, and a "power" of one inch is sufficient for its examination when cut into a thin section.

One point which deserves more attention than it has hitherto received, is the alteration which rocks have undergone subsequently to their consolidation, it is one of the great difficulties the petrologist has to contend with, but it is not insuperable. The polariscope will generally indicate the occurrence of metamorphism, and a careful search for the least altered portions of a rock may enable the enquirer to learn the history of the change, and thus gain a more correct knowledge of the original rock. It is clear, for example, that Olivine was one of the original constituents of the basalt above described, for its pseudomorphs occur in every part of the district in which the rock is found.

I venture to hope that the insertion of these observations in your valuable Journal may contribute in some slight degree to show that a *microscopical* analysis may be advantageously employed when a *chemical* analysis is impossible, and that the origin and structure of many rocks and minerals will not be accurately known till the microscope is far more extensively used than it hitherto has been by Geologists and Mineralogists.

VI.—ADDITIONAL NOTE ON THE UNCONFORMITY BETWEEN THE GREEN AND SKIDDAW SLATES.

By J. R. DAKYNS, M.A., of the Geological Survey of England and Wales.

THE Unconformity between the Green and Skiddaw Slates, which I pointed out in the last number of the GEOLOGICAL MAGAZINE, (see p. 56) as exhibited between Grange in Borrowdale and Dale Head will, I think, explain satisfactorily the Geology of Derwentwater.

If anyone refers to Ruthven's map of the Lake Country, (edition of 1855,) he will see the division between the two sets of beds drawn between Castlehead and Castlerigg, and thence in a south-west direction on the north side of Robinson. This is incorrect. Robinson and Hindscarth are both composed of Skiddaw Slates, and Castlehead, to the best of my belief, of Greenstone. The line I drew runs from Lowdore by the bridge at Grange to Dale Head, which is roughly parallel to Ruthven's line, but nearly a mile and a half distant from it to the south-east.

Thus it will be seen that while the western side of Derwentwater consists of hills of Skiddaw Slates, the eastern side, with the exception of a narrow strip near the water about Lowdore, is composed of hills of the volcanic series. Now were the two sets of beds conformable, as they have hitherto been generally considered to be, and as they have always been mapped, this would require a fault along the lake with an enormous throw, which would, doubtless, highly delight those persons who, having surveyed but little, fancy there are always faults along valleys, especially if the valleys are occupied by lakes. If, however, the two sets of beds are unconformable, of which I have very little doubt, then the structure of the country is perfectly intelligible, without calling in the aid of a fault, which, however, may exist for aught I know.

As I have alluded to those theorists who used to explain lakes as lying in open fissures caused by faults, of the existence of which fissures there is not a particle of positive evidence—a race of Geologists, which I fear is not yet extinct, though they doubtless received their death-blow in the excellent paper by Professor Ramsay on the origin of lakes—I may as well say that I saw several instances in the Lake Country of lakes lying in true rock basins; for instance, Thirlmere lies in a rock basin. Again, there can be no doubt, from the great spread of alluvium, that part of Borrowdale above the Bowder Stone was once occupied by a lake as far as Seatoller certainly, which lake probably split into two arms running some way up the two valleys of Stonethwaite and Seathwaite. Now this old lake was enclosed in a rock basin, the well glaciated barrier of which crosses the valley a little south of the Bowder Stone and blocks it up, save where the stream has cut a narrow channel for itself.

The gradual silting up of the lakes is also well exhibited in many of the still existing lakes. Derwentwater and Bassenthwaite are separated by a wide, low alluvial flat, but little higher than the levels of the lakes, which doubtless once formed one great lake reaching as far as Grange. Similarly, Buttermere and Crummock once formed one lake, which reached more than half a mile higher up the valley.

NOTICES OF MEMOIRS.

TRANSACTIONS OF THE MANCHESTER GEOLOGICAL SOCIETY. Vol. vii., Part 9, and Vol. viii., Part 1. 1868.

PART ix. contains a paper by Mr. P. S. Reid, on some copper, iron, and other mineral deposits of the Maritime Alps, in the districts of St. Sauveur, Valdeblore, and St. Martin de Lantosque.

The mines of St. Sauveur and Valdeblore are situated on the French and Italian frontier, about 35 miles from the town of Nice.

The predominant formation is Jurassic Limestone, under which and reposing on Mica Schists are metamorphic rocks, answering in a great measure to our New Red Sandstone formation, and in these the principal deposits of copper, now described, are found.

Beginning with the mines of Cluchlier, near Valdeblore, the whole structure of the mountain appears to consist of a series of red schists, alternating with beds of white sandstone passing into quartzite, the mass being several hundred yards in thickness and resting on massive aggregations of gneiss, which come to the surface at Millefonts, and are there found to be prolific in veins of iron ore.

The strata of schist and sandstone, which have been much metamorphosed, yield no organic remains, but in the Jurassic limestone or Lias, immediately above them, are found quantities of Belemnites and Ammonites.

French geologists consider the position which these rocks ought to occupy in the geological order of formations, quite an open question: some class them with the shales of the Lower Lias, some amongst the variegated sandstones of the Trias, and others amongst the Permian rocks, in consequence of certain analogies with the copper schists of Mansfeld; whichever may be their true position, the strata in question are eminently metalliferous, and the whole series occupies an extensive area in the "Alpes Maritimes" extending over forty or fifty miles of country.

With reference to the rich ores, they are chiefly Phillipsite, which is found mixed with certain proportions of sulphide and carbonate of copper. The usual gangues are clay-slates and quartz; but there are also found in them accidental fragments of other minerals, such as sulphate of baryta, fluor spar, specular iron ore, and chlorite.

Immediately to the north of the village of Rimplas, and on the opposite slope of the mountain called Cluchlier, another formation of copper has been discovered. Mr. Reid considers that these two deposits of copper, though differing greatly in character, will ultimately be found to be identical. It is well, however, to remark that the Rimplas formation partakes much more of the nature of that found in the Cornish copper mines than of that of Cluchlier.

Geologically considered, the enclosing rocks are precisely the same as those of Cluchlier. Several metalliferous and carbonaceous deposits crop out on the side of the mountain; and both here and at Cluchlier in the valley of La Bonlinette, are found two distinct beds of anthracite coal, of an excessively sulphureous nature. These coals do not appear in either case to be conformable with the red schists forming the enclosing rocks of the copper formation, but to belong to the Jurassic series.

About three to four miles north of the villages of La Bouline, La Roche, and the Cluchlier mines is situated the mine of Millefonts. Numerous outcrops of rich iron ores are traceable, by excavations crosscutting several yards of ore in eight distinct veins.

The minerals present two principal varieties, viz., micaceous specular iron ore, and compact red hematite.

These ores are very pure, and treated in a charcoal crucible have yielded seventy-two per cent. of iron.

On the western portion of this district a regular vein of massive galena, mixed with zinc blende, has been opened, with about five inches thickness of ore enclosed in gneiss passing into mica schist.

The assay of selected samples produced sixty-nine per cent. of lead, with fourteen ounces of silver to the ton of lead worked.

These mines of iron, though exceedingly rich in metal, labour under the disadvantage of want of mineral fuel. Wood certainly exists, and in fair quantities, but in the present day the competition with coke-made iron is too serious to induce large operations in them. Railways and good roads may some day make these valuable deposits available. At present their superabundance is excessive in comparison with the means of treating them.

The first part of Vol. viii. contains the Annual Report of the Council for the past year, etc.

SHORT NOTICES OF SCIENTIFIC PAPERS.

I. ENARGITE FROM CALIFORNIA. — MR. E. W. ROOT gives us the following account of this mineral:—[1]

It occurs both massive and crystallized in small rhombic prisms whose planes are much striated. The crystals possess a brilliant metallic lustre, are of a greyish-black colour, and about a millimetre in length. In the massive state it is somewhat coppery in colour when fresh fractured; exposed surfaces have a dark-bluish tarnish. It is very brittle. Streak black. Hardness about 4. Sp. grav. 4·34. B.B. decrepitates with violence, and fuses readily to a globule giving off arsenical and sulphurous fumes, and forming a coating of antimonous acid.

With fluxes it gives the copper reactions. It fuses readily at a gentle heat in a closed tube, giving off a yellow sublimate of sulphur, and at an increased heat a reddish sublimate of tersulphide of arsenic. It is insoluble in hydrochloric acid. Soluble in nitric acid with a residue of sulphur and antimonous acid. Associated with the specimen was a little iron pyrites and quartz, and a few small shining particles which, before the blowpipe, gave the reactions for iron and titanic acid.

In two analyses the following results were obtained:—

	No. 1.	No. 2.	Mean.
S,	31·81	31·51	31·66
Cu,	45·94	45·95	45·95
As,	13·65	13·74	13·70
Sb,	6·03	——[2]	6·03
Fe,	0·81	0·64	0·72
$Si\,O_2$	1·03	1·13	1·08
	99·27		99·14

If the iron present is considered as iron pyrites, and this, together with the silica deducted, the following mean is obtained:—

S.	Cu.	As.	Sb.
31·68	47·21	14·06	6·19 = 99·14.

This Californian Enargite differs from those heretofore described in having a much larger proportion of the arsenic replaced by antimony. It contains 6 per cent of antimony, whilst that from Chili, analyzed by Field, contained none; that from Peru, analyzed by Plattner, 1·61 per cent.; that from New Granada, analyzed by Taylor, 1·29 per cent.; that from Colorado, analyzed by Burton, 1·37 per cent.

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[1] For a full account, see Silliman's Journal, No. 137, vol. xlvi. pp. 201–203.

[2] In analysis No. 2, owing to accident, a part of the antimony was lost, but still some 5 per cent. remained.

The mineral was obtained with copper ore from the Morning Star Mine, Mogul District, Alpine Co., California.

II. OVER THE ANDES AND DOWN THE AMAZONS.—MR. JAMES ORTON records his observations made during a scientific expedition across the continent of South America in 1867.[1] The route was from Guayaquil to Pará *via* Quito, Rio Napo and the Amazons. Mr. Orton carried two mercurial barometers (one short, beginning to mark at 9,000 ft.), a Wollaston boiling-point apparatus, and Boussingault's ground thermometer. He tabulates more than 50 observations, commencing at the Pacific and rising to Arenal 14,250 ft., Pichincha 15,827 ft., Antisana 16,000 ft., Cotopaxi 12,860 ft., and descending the Amazon Valley to the Atlantic, which, if reliance can be placed on his barometic observations, stands two feet lower than the Pacific, off Ecuador. This he suggests may be due to the attractive power of the great chain of volcanic mountains of the Andes acting on the ocean at their feet. At Panama, he adds, the Pacific and Atlantic sink to a common level, for there the Andes drop down to an insignificant altitude. Mr. Orton's observations at Guayaquil, on the Pacific, were taken in July; those at Pará, on the Amazon, in January, with the same instrument.

Mr. Orton noticed some singular local variations of the barometer and boiling apparatus on the Amazons, and concludes, that of the two, the mercurial barometer is more reliable than the boiling-point apparatus. The heights, as given by other travellers, express the altitude above the Atlantic; Mr. Orton has taken the Pacific as his base-line.

If only we had a greater number of these data to deal with what important and interesting results might we not hope to arrive at.

III. GEOLOGICAL NOTES ON THE CAUCASUS.—CAPT. F. VON KOSCHKULL communicates some interesting Notes on the Caucasus,[2] or that region which divides the Black Sea and the Sea of Azoff from the Caspian Sea, and usually called the Isthmus of the Caucasus. This mountainous band unites Southern Russia with Asia Minor.

Capt. Koschkull sees evidence, in the valley of the Kur on the Caspian side, and the valley of the River Rion leading into the Black Sea basin, of the remains of straits which formerly united the Black Sea and the Sea of Azoff to the Caspian. He considers that the upheaval of the Karthlo-Imeritian Mountains and the plateau north of the Elbruz mainly caused the separation of these two basins which now stand at such different levels; for the Caspian is nearly 80 feet below the level of the Black Sea.[3]

[1] Silliman's Journal, No. 137, pp. 203-213.

[2] Silliman's Journal, Vol. xlvi., No. 137, pp. 214-221, and No. 138, pp. 335-347.

[3] The Caspian Sea has no inlet, and the waters may owe their depressed level in part to evaporation, the summers being very hot.

The central part of the principal chain of the Caucasus is composed of igneous and metamorphic rocks, as granite, gneiss, felspar, porphyry, diabase, melaphyre, basalt, diorite, trachytic tufa, obsidian and phonolite. The sedimentary rocks which cover the igneous rocks and enter so largely into the composition of the Caucasian mountains belong to the Jurassic and Cretaceous formations, including the Lias and Oolite (both largely developed), the Greensand, Gault, and White Chalk. The Tertiary strata representing the Eocene, Miocene, and Pliocene deposits, all rich in fossils, are spread over the plains bordering the great Caucasian chain. The older sedimentary deposits are considerably folded, and the Eocene and Miocene deposits exhibit some of the undulations of the subjacent rocks, but the Pliocene and "Aralo-Caspian" deposits are nearly always horizontal. This is extremely interesting as fixing the period of elevation of the chain in the Miocene epoch. Argentiferous Galena appears to be very widely distributed through the older rocks, and to have been extensively worked from a very early date by the Greeks, etc.

The Russian Government now possess the mines, and, in the few years that regular smelting works have been established, they have yielded 1,600 kilogrammes of silver, and 1,600,000 kilogrammes of lead.

Coal of Jurassic age occurs on both slopes of the Caucasus, and during the last ten years has been mined by the Russians at Kuban to the amount of 4,000,000 kilogrammes per annum. On the banks of the Rion, the coal-beds have an aggregate thickness of 28 feet.

Extensive Rock-salt mines of Tertiary age also occur, and most ancient workings were seen by the author, in which he discovered hundreds of stone implements, evidently used as mining tools, formed with considerable skill out of a tough hornblendic rock. Salt is not only procured abundantly from the Rock-salt mines but also from the evaporation of the salt-lakes in the Caucasus. The former yield about 24,000,000 kilogrammes, and the latter 16,000,000 kilogrammes, annually. Sulphur and alum also occur in abundance. Abundant supplies of petroleum, varying in density from very fluid, light-yellow oil to viscid, dark-brown mineral tar and asphaltum, occur in the Upper Tertiary strata, and, like the rock-salt mines, some of the oil-wells are of unknown antiquity.

On the eastern shore of the Caspian 20,000 wells have been sunk with proportionate results.

Captain Koschkull gives the estimated annual yield of three oil regions in the Caucasus as follows:

	Kilogrammes.
1. Peninsula of Abscheron	8,640,000
2. Valley of the Kur	192,000
3. Valley of the Saundga	320,000

Mud volcanoes now or recently in action occur in the peninsulas of Abscheron and Taman.

The craters of these volcanoes are from 200 to 1,000 feet in height, and sometimes 700 feet in diameter. Thermal springs are also abundant. Since the complete subjugation of the country by the Russians in 1864, efforts have been made, with more or less success, to develop the resources of this interesting region, so full of relics of the early races of mankind, and so rich in classical reminiscences.

REVIEWS.

I.—VESUVIUS. By J. PHILLIPS, M.A., etc. Printed at the Clarendon Press, Oxford, 1869.

II.—MOUNT VESUVIUS, ETC. By J. LOGAN LOBLEY, F.G.S. Stanford, 1868.

THE past year has been signalized by a more than ordinary activity in the subterranean phenomena of seismic and volcanic disturbance. And hence, perhaps, has arisen a more general desire for information on these subjects to which we owe the two publications of which the titles are given above.

The work of Professor Phillips is, as might be expected, by far the most scientific and authoritative. It forms the substance of lectures delivered before the University after his return from a visit to Naples in the spring of last year, and is illustrated by numerous woodcuts, chiefly from the Professor's own pencil; others being reduced copies of authentic drawings, or engravings of earlier dates. Its contents are arranged in a threefold division. The first, containing a history of the mountain called Vesuvius, and its successive eruptions, by far fuller and more complete than any to be found in the works of Hamilton, Lyell, Daubeny, or the other writers on the subject. The second arranges the main facts and phenomena which have been observed in and around Vesuvius in a settled order. The third attempts the interpretation of these observations by reference to the physical and chemical laws of nature, giving, in fact, the Professor's view of the character and origin of volcanoes in general.

The first recorded eruption of the mountain, is that of A.D. 79, so graphically described in the well-known letter of Pliny the younger, relating to the death of his uncle, and to which catastrophe the cities of Pompeii, Herculaneum, and Stabiæ, overwhelmed by accumulation of ejected ashes, owed their destruction.

By the explosions of this eruption one half of the circumference of the old crater, which more than a century before had sheltered the banditti of Spartacus, was blown into the air; the remaining segment still forming the hollow semi-cone called Somma. The author justly, as we think, supposes that before the formation of this early crater, the slopes of Somma were continued all around up to a single conical summit, probably 3,000 or 4,000 feet higher than the present mountain. The subsequent eruptions, which have continued with more or less intermission to the present day—quiescent intervals lasting sometimes for centuries, at others only for a few years or months—have raised the existing cone of Vesuvius in the centre of the old crater, of which the western border remains only as a low rim occasionally overtopped by the flows of lava from above. This modern cone has, by these eruptions, been not only by degrees greatly enlarged and heightened, but also repeatedly emptied by paroxysmal explosions, and again filled by minor eruptions of lava and fragmentary matter from the bottom of the crater so formed. The last of these great crater-forming paroxysmal eruptions occurred in 1822, by which some six hundred feet of the top of the mountain were blown off. Since which time not only has the great crater then formed—nearly three miles in circumference, and upwards of 1,000 feet deep—been re-filled and re-emptied more than once, but a new and solid cone has been raised above to a greater height than the mountain had before 1822. These changes are well exemplified in the woodcuts given in this volume, and it is evident, that, from the accumulation of the fragmentary matter and lavas so continually emitted, the mountain is rapidly growing in external bulk; so that, if the process continues, we may anticipate, with the Professor, a time when the valley called the Atrio, which now separates the cone of Vesuvius from the half-encircling ridge of Somma, will be obliterated, and the whole form but a single conical mountain of as great height and bulk as it probably had some 3,000 years ago. If it be asked, what has become of the matter ejected from the central hollows so repeatedly blown out and re-filled within the heart of the mountain? The answer is, it has been spread by the winds in showers of ashes over the surrounding lands and seas to the distance sometimes of hundreds of miles. The lavas do not always proceed from the summit of the cone, but often well out at lower levels from radial fissures broken through its sides, and these streams consolidate into buttresses, which, together with the heavier ejected fragments that fall from the air, add continually to the bulk and strength of the entire mass. One of the latest and most remarkable phenomena was the elevation to the amount of three and a-half feet of the sea coast at the foot of the mountain in front of Torre del Greco, behind which town, and at no great distance, one of these lateral eruptions was at the moment taking place from no less than ten openings in a line from the axis of the cone.

The author adds to his history and description of Vesuvius a similar, but briefer, account of the adjoining Campi Phlegræi, and justly refers the production of the numerous craters of this district, with their encircling hills of tufa, to submarine eruptions on a shallow shore. To the same process he ascribes the much contested origin of the Monte Nuovo, the latest formed of these cones and craters. For, we need hardly say, the Professor is no partisan of the untenable doctrine of "upheaval craters," which has so confused the ideas of many Geologists on the phenomena of volcanoes. Submarine tuffs, more or less stratified, and dating probably from the period when these Phlegrean vents were in greatest activity, form the substratum of Somma itself, as well as of nearly all the Campania around, and have been raised to their present position, together with the general line of coast, by those subterranean movements of which the (so-called) Temple of Serapis, at Pozzuoli, presents a recent minor example.

In the tenth chapter, the Professor gives a very complete and exhaustive list of the very numerous minerals found in the lavas, or fragmentary ejecta of Vesuvius, the result probably of their long and repeated exposure to fusion, reconsolidation, and chemical changes within the focal reservoir. Speaking generally, the lavas of Vesuvius have always been doleritic (composed of augite and leucite chiefly); while those of the Phlegrean fields and Ischia are trachytic (felspar taking the place of leucite).

In considering the theory of volcanic excitement (in which that of earthquakes is properly included), the author leans to the views of those who think the interior of the globe to be in a state of fluid fusion; and rejecting, with M. Delaunay, the opinion of Hopkins, that proof of its solidity can be derived from the precession of the equinoxes, attributes to the slow contraction by cooling of the exterior crust, the fractures, and local elevations and depressions, which it has evidently suffered; and in some degree also to the change of volume in the subterranean rocky matter, while passing from a fluid to a solid crystalline condition. The particular phenomena of volcanoes are ascribed to the penetration of water from seas or lakes, to the heated and liquid interior, through fissures formed during these more general and deeply seated movements. Perhaps the latter is the least satisfactory of these hypothetical agencies. The penetration of water to any great depth *within* a mass of *fused* rocky matter—and it is certain that all the phenomena point to the existence of water (or steam) within, and even below, masses of subterranean lava—seems to us a scarcely conceivable idea. M. Daubrée, and, still later, M. Fouquè, have broached the opinion that water penetrates everywhere by infiltration, or through crevices to great depths. But this presupposes the matter into which it finds its way to be solid, and, therefore, only subsequently liquified, whether by increase of heat or reduction of pressure. This seems to us the more probable hypothesis; though, after all, there is perhaps no sufficient reason for the belief that the water present in, and intimately disseminated throughout, the matter from which lavas are formed, did not exist in it *ab initio*, as one of its component elements, instead of having been introduced *ab entra.* If this be admitted, local changes of volume, occasioned by the shifting of caloric, will then account for all the phenomena of fracture, elevation and depression, as well as for volcanic outbursts, whenever the heated and liquefied matter could force its way through any fissure into the open air, and the contained water consequently flash into steam-bubbles.

On the whole, the volume of Professor Phillips is an admirable monograph of the great Campanian volcano, and should be employed as a manual by every one who may visit Naples, and desires authentic information on the most interesting feature in its enchanting scenery.

The small work of Mr. Lobley contains a lively sketch of the same subject, very agreeably written, and correct in the account it gives of the Geology of the mountain and its products, but with no pretensions to the completeness and scientific character of that of the Oxford Professor. Its most interesting portion, perhaps, is the narrative of the ascent of the volcano by the author in the spring of last year, while in full eruption. The volume contains several good and accurate maps and sketches.

II.—STONE IMPLEMENTS FROM JAVA.

BY M. ROULIN.

[**Rapport sur une collection d'instruments en pierre découverts dans l'île de Java, et remontant à une époque antérieure à celle où commence, pour ce pays, l'histoire proprement dite. (Extrait.) (Commissaires: MM. Daubrée, Roulin rapporteur.) Comptes Rendus de l'Acad. des Sciences, Paris, 28th December, 1868.**]

THE specimens described in this report were collected by M. Van de Poel, of Cheribon, and forwarded by him as a present to the French Government.

The collection comprises thirty-nine articles of polished stone, which were successively dug up from great depths in the soil. They belong to a period antecedent to all the records and traditions of the country. It is difficult to obtain any from the natives, owing to the adoration they profess for them.

The specimens differ in general aspect from any already in the possession of the Academy; they are remarkable for the beauty of the materials out of which they have been shaped, and for the symmetry of their forms. They vary in size from 385 millimetres in length, to only 26 millimetres; these being the two extreme measurements.

Owing to the want of any information relating to the mode of occurrence of the specimens, the report is confined to their direct examination, and the comparison of them with analagous modern objects.

They nearly all of them belong to implements of labour; there are besides three bracelets and a thin plate of oval shape probably "*distinée à une incrustation,*" which from their style of workmanship are evidently to be associated with the other specimens. There is a very striking absence of all kind of arms. It is impossible to suppose that the ancient Javans were entirely wanting in weapons of warfare or of the chase; but perhaps these were made of wood, like those now used over a large portion of Polynesia. Under ordinary circumstances it does not require many years to efface the traces of such arms. Still some vestiges would have escaped the common causes of destruction, and they will, when discovered, become the objects of much interest.

Fifteen only of the thirty-five implements are entire, but some of the others, though not perfect, are of great importance.

One of these latter, made of a greyish flint, formed part of a strong blade 25 millimetres in thickness, smooth beneath, slightly convex above, of a uniform width and thickness (82 and 25 millimetres respectively). Its length, which at first must have been, so far as we can judge by its other dimensions, from 12 to 15 centimetres, is no more than eight; in this state it was still large enough to be made useful, and by the following expedient. It was necessary to make a new edge, and it was first cut square. This was performed by two saw-cuts made on the opposite faces, and continued so as nearly to meet, the separation having, however, been finished by fracture. The stone appears to have been attacked first on the convex side, which is more deeply cut, and, strange to say, the depth of the notch is likewise convex.

This cutting or sawing may have been performed in a manner similar to that practised by the inhabitants of St. Domingo, and their neighbours on the adjoining continent, as recorded by Oviedo, who visited the country in 1513. With sand and a thread of *Cabuia* or *Henequen* (two species of Agave) they can cut iron. They make use of the thread as we should of a saw, drawing it alternately from right to left, during which they move about and rub quickly against the iron very fine sand, which they have previously spread along the passage.

Some of the other specimens have been cut in a similar manner. In the majority of the Javan specimens the edges are square, and the thickness nearly uniform — features that are characteristic of the Scandinavian celts.

The implements seem all adapted for cutting wood. Some of the heavier specimens must have needed both the arms of a strong man to wield them, and they probably were used for chopping down trees, whilst the smaller tools, which could be used with one arm, were intended for more delicate work.

All have been shaped on a similar plan.

They offer in general a single cutting edge formed at the expense of the lower face, which is even or slightly concave, like our modern adzes.

They have been formed from Flint, Chalcedony, Jasper, Porphyry, Aphanite, Sandstone, etc.

The report is illustrated with a plate, representing an adze from the Isle D'Oualan (Carolines), and an ancient implement found in Egypt, which are very similar to the forms from Java, described by M. Roulin. "Palæoethnologists" will be much indebted to M. Van de Poel for the interesting collection he has made; but it is hoped that he will further enhance the value of the collection, by furnishing a few details in regard to the deposits from which the specimens were obtained.

III.—CAIUS JULIUS CÆSAR'S BRITISH EXPEDITIONS FROM BOULOGNE TO THE BAY OF APULDORE, AND THE SUBSEQUENT FORMATION GEOLOGICALLY OF ROMNEY MARSH. By FRANCIS HOBSON APPACH, M.A. 8vo. pp. 143. London: John Russell Smith, Soho Square. 1868.

THE main object of Mr. Appach's book is to discuss the probable points of Cæsar's departure from Gaul, and his landing in

Britain. With this end in view, the author enters more fully than historians are wont to do into the question of possible changes of coast-line since Roman times. In the following remarks we will take the liberty of passing over Mr. Appach's historical disquisitions, and will confine ourselves solely to the Geological points involved. That Geology has much to say upon this question, no one who has studied our south-eastern coasts can doubt. Most writers upon this subject hitherto have too much neglected the Geological arguments, from an assumption that any changes which may have occurred during the last 2,000 years are quite insignificant. In Mr. Appach's opinion they are of great importance.

Romney Marsh, as it at present exists, is a great spread of alluvium, bordered in many places on the sea-side by shingle; particularly so at the south-eastern extremity (Dungeness), where the point is yearly extending further seawards from the accumulation of beach. This shingle border is slightly raised above high-water-mark, and forms a protection to the Marsh which, where not thus preserved, is artificially embanked to keep out the sea. The alluvium is almost wholly below high-water-mark. Its highest point is near New Romney, from whence it falls away to the north and west. The lowest points are just below the old line of cliffs, where the Military Canal now runs. The river Rother flows through the western part of the Marsh into the sea at Rye.

The general opinion hitherto has been that the Marsh in Roman times had to a large extent been formed, and that the Rother (Limen) flowed past Appledore, eastwards, nearly along the present line of the Military Canal, and emptied itself into the sea at Lympne (Portus Lemanis); that subsequently, at an unknown date, its course was altered, and that it flowed east and south-east to Romney. Still later, in the middle of the 13th century, during violent storms, the channel was once more altered.. The river then ceased to run out at Romney, and opened for itself a shorter cut to Rye, its present outlet.

Mr. Appach's first argument to prove that Romney Marsh, in its present state, had no existence in Roman times, is the absence, with one exception (Appledore Dowls), of Celtic names, and the presence of only two or three of Latin origin, all others being Saxon. "These facts are significant. They suggest the conclusion that the marshes were not in existence in the time of the Celts, but that the sea then ran inland as far as Robertsbridge, and formed the Bay of Apuldore; that the Romans were settled at Lydd and Romney and were the builders of the Rhee Wall; and that it was not until the Saxon period that the interior of the marshes was inhabited." (p, 13.)

After describing somewhat minutely the present form of the marshes, and the shingle, sand, silt, etc., of which they are composed, the author goes on to give his explanation of their origin, which, as it differs somewhat from that usually accepted, we will notice more at length. Assuming that the slightly elevated land in the neighbourhood of Romney formed an island in Roman times, and that the sea flowed over what is now marsh land, he supposes that the rising tide carried sediment into the bay, and deposited it behind the island; thus gradually silting up this part of the bay. At the same time, by the eddy in the bay, silt would be deposited on the south-west of the island, the main stream at low water flowing out between these shoals. The old island of Romney gradually extending northwards, towards the coast of Kent, finally shut out the waters there entirely; but the western shoal never quite reached the mainland, and there has always been a channel on its western side, where the Rother now runs.

The foregoing is a very bald sketch of Mr. Appach's views, in support of which he quotes from previous writers. His own observations are numerous, and this part of the volume forms a useful contribution to Geological literature.

It will be seen that Mr. Appach differs materially from those who regard Romney Marsh wholly as the *delta* of the Rother, and he aptly remarks that whilst deltas invariably have an inclination from the land towards the sea, marshes formed by the sea, as Romney Marsh, slope inwards towards the land (p. 24). Of course it would not be denied that the sediment brought down by the Rother has greatly aided in silting up the area. In Mr. Appach's supposition regarding the earlier stages in the formation of the Marsh, with the formation of shoals, and the gradual deposition of silt around them, he does not much differ from opinions which have been published before, but his account of subsequent events departs somewhat from the common explanation. Thus by the gradual extension of the eastern island (Romney) landwards, the sea was shut out on the east side, and the water at ebb tide drained west and south-west into the main channel between the islands. Mr. Elliott[1] holds that whilst the River Limen never ran out at Lympne along the north side of the marsh, yet that the backwater scoured along a channel here, forming the ancient harbour of Lympne, and that this channel gradually silted up. The common belief is that the River Limen itself occupied this channel until its course was altered to Romney. The present appearance of the marshes gives but little evidence upon this question. There is no trace of the supposed river course west of Lympne, whilst that to Romney is still plainly traceable.

The French coast has undergone fewer changes; but such as have occurred are not unimportant. The chief agent in change has been "blown sand," which has, more or less, choked up the river mouths; the harbour of Boulogne being even now kept open with difficulty. We may here note a Geological error into which Mr. Appach has fallen in regarding the cliffs north and south of Boulogne as being composed of Wealden Rocks. They consist of Portland and Kimmeridge Beds, with only occasional thin patches of Wealden on their summits.

In conclusion, we may briefly note the historical application which Mr. Appach makes of these changes in fixing the place of departure from Gaul selected by the Romans, and that of their landing in Britain. Mr. Appach regards Cæsar as sailing from Boulogne towards Hythe, and then coasting northwards towards Deal, until stopped by the tide. Turning back, he sailed again along the coast into the bay which then existed west of Hythe, and landed at Bonnington. In his second voyage Cæsar sailed again from Boulogne, and drifted northwards towards the South Foreland, then, as before, returned along the English coast into the "Bay of Apuldore."

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[1] "Account of the Dymchurch Wall." Proc. Inst. Civ. Eng., vol. vi. p. 467, 1847. Appendix to C. R. Smith's Report on Lymne, 4to., 1852, p. 41.

The book is illustrated by a map showing the supposed coast line in Roman times, also the directions taken by the Roman fleet in each voyage. We recommend the volume to all interested in the coast changes and superficial deposits of our south-eastern counties.

W. T.

REPORTS AND PROCEEDINGS.

ROYAL SOCIETY OF EDINBURGH.—On the 15th February, a meeting of the Royal Society was held in the Society's Hall, Royal Institution, Dr. Christison, President of the Society, in the chair.

Progress of the Geological Survey of Scotland.—At the request of the Council, Mr. Geikie, the Director of the Geological Survey of Scotland, addressed the Society upon the the progress of the Survey. He began by sketching the labours of previous geologists, dwelling more especially upon those of Boué, Macculloch, Maclaren, Murchison, Nicol, etc. Passing then to the result obtained by the Survey in Scotland, he said that the area which has now been mapped in Scotland amounts in all to about 4,100 square miles. Of this area, 2,269 square miles have been published on the one-inch scale, about 800 square miles are now in the course of being engraved, and the rest is in progress. Nine sheets of the one-inch map have been published, comprising the whole or parts of the counties of Edinburgh, Haddington, Linlithgow, Fife, Kinross, Peebles, Selkirk, Lanark, Ayr, and Kirkcudbright. In addition to these maps on the scale of one inch to a mile, there are also issued maps of the coal-fields on the scale of six inches to a mile. Of these maps, thirty-six sheets have been published, including the coal-fields of Mid-Lothian, East Lothian, Fife, and Ayrshire. A considerable number more, now in the hands of the engraver, embrace the northern half of the Ayrshire coal-field, with part of the great coal-basin of the Clyde.

The speaker then proceeded to give some account of the chief scientific results obtained by the Geological Survey of Scotland, during the four years which had elapsed since he last addressed the Society upon this subject. Beginning with the oldest rocks examined, he showed the area of Silurian strata which had been mapped, including the richly fossiliferous districts of Carrick, from which a large number of fossils had been obtained. Within the last few months an important discovery has been made by one of the younger members of the Survey, Mr. R. L. Jack, viz., the occurrence of a bed of fossiliferous conglomerate, which has been traced for about five miles among the Lower Silurian rocks of the Leadhills. The fossils have not yet been examined, but there seems much probability that this bed will prove to be a prolongation of the well-known Wrae limestone, and thus define the age of the strata of the Leadhill district. A large area of Old Red Sandstone has now been examined, including the whole region between the Pentland Hills and the south-west of Ayrshire. Three distinct divisions have been ascertained—an upper series, graduating upwards into the Carboniferous formation, and best seen in the eastern parts of the kingdom, a middle group, extensively developed, to the south of the town of Ayr, and a lower group, which reaches an enormous thickness, in the centre of the Lowlands, and passes down into the Upper Silurian. In this lower division, as it approaches its north-eastern limit, a remarkable local unconformity has been ascertained by the recent researches of Mr. B. N. Peach and Mr. Geikie. In the Pentland Hills, the conglomerates and sandstones rest upon the vertical abraded edges of the Upper Silurian rocks; while only a few miles distant, in the parish of Lesmahagow, there is no such break, but the one series passes regularly into the other. The Pentland Hills, therefore, contain two groups of strata, both belonging to the Lower Old Red Sandstone, but the one lying quite unconformably on the other. The great development of contemporaneous igneous rocks associated with these strata, may possibly be connected with the origin of this local break in the succession of the deposits. Much attention has been bestowed by the Survey during the last few years upon the lower members of the Carboniferous system. The result has been a twofold division of that hitherto vaguely defined set of strata known as the "calciferous sandstones," between the top of the Old Red Sandstone and the base of the Carboniferous Limestone. New light has consequently been thrown upon the history of the earlier portions of the Carboniferous period in Scotland. The lower part of the calciferous sandstones consists of a thick but variable group of red sandstones, extensively developed in Ayrshire, Arran, and Bute, and stretching across the island to the coast of Haddington and Berwick. Between these Lower Sandstones and the base of the Carboniferous Limestone, comes a group of strata possessing much interest from the variations which it exhibits in thickness, and in the nature of its component strata. In some districts it is altogether absent, and then the Carboniferous Limestone and the Red Sandstones come together. But again, at no great distance, it reappears, and soon acquires a considerable thickness. In the western part of the country it consists of grey and white Sandstones, pale grey, green, or mottled marls and shales, with bands of cement-stone, sometimes with dark shale and ironstone. The Ballagan beds of the Campsie Hills belong to this group. In the eastern half of the country, throughout the Lothians, it is made up of thick white sandstones, black shales, ironstones, some beds of Limestones, and even of coal, its most important components being those bituminous shales from which oil is now so extensively obtained. In the east of Fife it contains a great many bands of Limestones, having the fossils and general aspect of true Carboniferous Limestone beds, while in Berwickshire it reassumes the aspect which it shows in Ayrshire and the west.

An important feature in the recent work of the Survey is the mapping of the Permian basins of Ayrshire and Thornhill, and the discovery of a beautiful series of contemporaneous igneous rocks associated with the Permian sandstones of both these localities.[1]

In connection with this subject, Mr. Geikie remarked that the detailed labours of the Survey had now brought to light the history of a long, though interrupted, series of volcanic phenomena, dating from the time of the Lower Old Red Sandstone, and extending even into the Tertiary period. Of these igneous rocks, the oldest group forms the range of broken hilly ground, which stretches from near Edinburgh south-westward through Lanarkshire, into the south of Ayrshire. The next series, in point of age, is that which belongs apparently to a middle division of the Old Red Sandstone, and forms the hills to the south of the town of Ayr. Then come indications of volcanic activity in the Upper Old Red Sandstone of the east of Scotland. The earlier half of the Carboniferous period in Scotland, was marked by the abundance and activity of the volcanos. The remains of the lavas and ashes then erupted form the hills in the north of Ayrshire and Renfrewshire, and most of the craggy hills which roughen the area of the Lothians and of Fife. Next in order of time are the interesting traces of volcanic action associated with the Permian rocks of Ayrshire and Nithsdale, which will be described in a forthcoming portion of the Memoirs of the Geological Survey. The most recent igneous rocks yet traced are dolerite-dykes, which run across all the other rocks and even cross large faults without any deviation. These Mr. Geikie believes to be connected with the great dolerite plateau of Antrim and the western islands, and to be of Miocene age.

Several areas of Metamorphic rocks have been mapped in detail, particularly by Mr. James Geikie, and the gradual passage of different stratified rocks into crystalline porphyries and granite rocks, has been traced both in the Lower Silurian and the Lower Old Red Sandstone districts.

The mapping in of the superficial deposits has been steadily prosecuted along with the survey of the rocks underneath. Particular attention has likewise been bestowed upon the traces of ice-groovings, and it will, probably be possible, before many years are gone, to shew on a map, and in some detail, the movements of the great ice-sheets of the Glacial period. While these researches are advancing, attention is necessarily drawn every day to the connexion between the external form of the ground and the structure of the rocks below. A mass of evidence has now been accumulated by the Geological Survey, to show that, as was originally maintained by Hutton, the present outlines of the country are not to be traced back to the operation of underground forces, but mainly to the action of subaerial agents. In proof of this statement the speaker indicated the lines of the great faults ascertained in the course of the prosecution of the Survey, and showed that, instead of coinciding with lines of fault, the valleys in reality run across the faults in all directions, and without any reference to their existence. He concluded by congratulating the Society upon the growing recognition of the pre-eminent genius of Hutton, whose views were first promulgated within the walls of the Society. Hutton he regarded as the father of modern physical geology, and we are now only coming abreast of him, so far was that great man in advance of his time. All the examination and scrutiny which the detailed work of the Geological Survey involves has hitherto only served to confirm and extend the views which Hutton was the first to enunciate.

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[1] See Geol. Mag. Vol. III. p 243.

Geological Society of London.—January 27th, 1869.—1. "Notes on Graptolites and allied Fossils occurring in Ireland." By W. H. Baily, Esq., F.G.S. [First Paper.]

After remarking that the Graptolites are now generally regarded as belonging to the class Hydrozoa, the author detailed the various localities in the south of Ireland in which they had been found, and indicated the species occurring in each place. The localities are situated in the counties of Waterford, Wexford, Clare, and Tipperary; and the species are as follows:—

Didymograpsus sextans, Hall.
,, *elegans*, Carr. (= *D. flaccidus*, Hall? Nich.).
Didymograpsus caduceus, Salt.
,, *Forchhammeri.*
Graptolithus (*sagittarius*) *Hisingeri*, Carr.
,, *Sedgwicki.*
,, *tenuis.*
,, *priodon.*
Cladograpsus gracilis, Hall.
Diplograpsus pristis, His.
,, *mucronatus.*
,, *teretiusculus.*
,, *dentatus*, Brongn.
Climacograpsus bicornis, Hall.
Dicranograpsus ramosus, Hall.
Cyrtograpsus gracilis, Hall.
,, *hamatus*, Baily.

The most widely distributed of all is *Diplograpsus pristis*, to which the author thinks *D. mucronatus* and *dentatus* probably belong. The fossils described by the author as *Theca cometoides* may probably be the gonothecæ of *D. pristis*, as had been suggested by Mr. Carruthers.

Discussion.—Mr. Carruthers remarked that while almost all observers have referred these creatures to the *Hydrozoa*, there was an impression abroad, founded on a misconception of a remark of Prof. Huxley's, that he classed them as *Polyzoa*. He had, however, Prof. Huxley's authority for saying that he did not so regard them.

2. "Notice of Plant-remains from beds interstratified with the Basalt in the county of Antrim." By W. H. Baily, Esq., F.G.S.

The deposit referred to by the author was discovered by the late Mr. G. V. Du Noyer in cuttings of the Northern Railway of Ireland near Antrim; it consists of a layer from 4 to 8 inches in thickness, separated by a conglomerate bed of 10 or 12 feet from the underlying basalt, and by earthy beds of about equal thickness from the superficial basaltic layer. The remains are embedded in a Red Clay, and associated with hæmatitic iron ore.

The author regarded a large cone as that of a true *Pinus*, and branches of another coniferous tree as belonging to a *Sequoia* nearly allied to *S. Sternbergi*, Heer; of this a small imbricated cone might possibly be the fruit. Other fragments of Coniferæ seem to belong to *Cupressites* or *Taxites*. The fossils consist chiefly of leaves of true Dicotyledonous plants. The author identified some of these with species of *Rhamnites*, *Olea*, *Fagus*, and *Quercus*. Leaves of endogenous plants, such as Sedges and Grasses, occur not unfrequently. A large mass of fossil wood of dicotyledonous structure was obtained from the hæmatitic conglomerate. *Carpolithes* are also found. The vegetable remains are accompanied by a few elytra of Beetles.

The author remarked that these remains seem to differ as a group from those of the Island of Mull. Their alliance appears to be with Mid-European forms, and they are certainly of Upper Tertiary age, probably Miocene.

Discussion.—Mr. Carruthers observed on the difficulty of determining species, or even genera, satisfactorily, from such fragmentary evidence as that adduced by Mr. Baily. He considered that the small cone did not belong to *Sequoia*, inasmuch as the cone of *Sequoia* was not composed of imbricated, but of adnate, peltate scales. The wood was not only dicotyledonous, but coniferous.

Mr. David Forbes remarked that the existence of this leaf-bed might be regarded as affording grounds for belief in the non-igneous origin of basalt. He had, however, made experiments as to the non-conducting-power of clay, and had found that even half an inch of clay was sufficient to protect vegetable forms from destruction by the heat of a mass of slag allowed to flow over them. In the same manner he had found the forms of trees still preserved under the lava of Vesuvius.

Mr. R. H. Scott called attention to the work of Dr. Heer on the specimens brought home from Greenland by Dr. Whymper, among which he had recognised the fruits of various plants which had already been identified by him from the leaves. The connexion between these beds and those of Bovey Tracey, Disco Bay, and other Miocene deposits throughout Europe was now proved; and the recent importations by the Swedish Polar Expedition would throw further light on the subject. No doubt further discoveries would also be made of a similar character in the North of Ireland. He pointed out the similarity between the Irish section and those of Greenland, where vegetable remains were also found interstratified with basalt.

3. "Remarks upon the Basalt Dykes of the Mainland of India, opposite to the Islands of Bombay and Salsette." By G. T. Clark, Esq., F.G.S.

The author described the general features of the country referred to, and stated that the dykes which traverse it vary from 1 or 2 to 100 or 150 feet in width, and often extend many miles. They are all basaltic, with a tendency to prismatic structure, but never columnar. The adjacent Trap is but little modified, only somewhat hardened, so as to resist weathering; by this means long, narrow ridges, more or less deeply furrowed above by the weathering of the basalt dyke itself, are produced. The general direction of the dykes is parallel to the lines of volcanic vents; those near the main axis of the Concan lying N. and S., and those near the subordinate axis in the Malseji valley, about E.N.E. and W.S.W. They run nearly straight, and have their faces usually parallel, but sometimes swell out or contract, or include a rider. The author considered that these dykes were formed probably during the latest periods of volcanic action in Western India. They probably belong, in his opinion, to two periods, as dykes of different grain frequently intersect each other. The dykes running N.E. and S.W. often traverse and slightly dislocated those lying more N. and S., and are probably of later date.

Discussion.—Mr. David Forbes did not see any proof of the dykes being of different ages. In modern eruptions, lasting over some years, the lava first erupted sometimes became fissured, and the fissures filled at a later period of the eruption.

4. "On Auriferous Rocks in South-eastern Africa." By Dr. Sutherland. Communicated by Sir R. I. Murchison, Bart., F.R.S., etc.

Fourteen years ago the author expressed the opinion that gold would be found in the metamorphic rocks of Natal. A few months since Mr. Parsons found this metal by washing the iron sand of some of the southern rivers of the colony. The gold is in microscopic rounded grains. Dr. Sutherland considers that the gold is diffused as minute particles in the granite and gneiss underlying the Silurian rocks of South Africa.

These old gneissic rocks are very much contorted, include extensive veins and lenticular masses of quartz, and are traversed by basalts. The Silurian strata, resting unconformably on the gneiss, have been invaded by igneous matter (which is never granitic), and though generally horizontal, are frequently flexuous, and in some places greatly faulted, to the extent of even 1000 feet, together with the gneissic rocks beneath. These latter have been deeply eroded by the rivers, frequently to the depth of 500–1000 feet, and even of 3000 feet in some valleys; and in the alluvia of these valleys the gold occurs. The valleys have sometimes evidently commenced in great displacements, forming "valleys of elevation," on which the denuding agency has been operating ever since.

In certain mountains in the basin of the St. John's River, Natal, dioritic rock traverses the secondary strata; and along the line of contact it contains copper-ores with 100 grains of gold to the ton.

II.—February 10th, 1869.—1. "On the Evidence of a ridge of Lower Carboniferous Rocks crossing the Plain of Cheshire beneath the Trias, and forming the boundary between the Permian Rocks of the Lancashire type on the North and those of the Salopian type on the South." By Edward Hull, Esq., M.A., F.R.S., F.G.S.

In this paper the author proposed to account for the dissimilarity of mineral and stratigraphical characters of the Permian formation of Lancashire and the North of England as compared with that of the Midland Counties and Shropshire, on the ground that they had originally been deposited in separate basins, divided off from each other by a ridge of Lower Carboniferous rocks, stretching from west to east, under the central plain of Cheshire.

The author showed that there was evidence of such a ridge on the east side of the plain of Cheshire, by the uprise of the Lower Carboniferous rocks to the north of Congleton edge, in the valley of the River Dane, and that the date of this uprise and the denudation of the Upper Carboniferous beds along the axis of elevation was clearly determined to be antecedent to the Permian period by the outlier of Permian rocks at Rushton Spencer.

On the west side of the plain there was evidence of a similar axis of upheaval to the south of the Flintshire Coal-field near Hope, where the Lower Carboniferous rocks (Yoredale and Millstone beds) are brought up to the surface at the margin of the New Red Sandstone.

Mr. Hull regarded the uprise on each side of the plain as referable to the same Pre-Permian age, and as belonging to the East and West system of flexures into which the Carboniferous rocks were thrown at the close of the Carboniferous period over the north of England. Such an axis had its antetype in the concealed ridge which once occupied the valley of the Severn, and divided the Devonian rocks of Devonshire from those of South Wales; and the author suggested that a similar ridge, now concealed beneath the Triassic formation of Cheshire, offered the only satisfactory explanation of the dissimilarity in the two types of Permian beds—that of Lancashire, and that of Shropshire and the Midland Counties.

Discussion.—Prof. Ramsay considered that the lithological differences in the Permian rocks of the two areas referred to were hardly so great as was supposed by Mr. Hull.

Mr. Prestwich remarked that the nearly equal thickness of the Permian deposits in the two areas was in favour of their having been deposited in continuity.

Mr. W. W. Smyth considered that the difference between the Permian beds in question was not so great as the author supposed, but that the undoubted existence south-west of Chester of a breadth of five or six miles of Bunter Sandstone lying immediately upon the Millstone Grit, although observed only at one point, was strongly in favour of the author's hypothesis.

Mr. Hull stated in reply that the difference between the two groups of Permian rocks to which he had referred was such as to cause their identity to appear at first sight very doubtful. The extent of the anticlinal at Rushton Spencer is so great that it must be inferred to have extended far both to the east and west.

2. "On the Red Chalk of Hunstanton." By the Rev. T. Wiltshire, M.A., F.L.S., F.G.S.

The author described the section exposed in Hunstanton Cliff as showing:—1. White Chalk with fragments of *Inocerami*. 2. White Chalk with *Siphonia paradoxica*, having its base undulated and the cavities filled up with a thin bright red, argillaceous layer, resting upon (3) the Red Chalk, which is divisible into three sections: *a*, hard, containing *Avicula gryphæoides* and *Siphonia paradoxica*, and with fragments of *Inocerami* at its base; *b*, hard, rich in *Belemnites*; *c*, incoherent at its base, rich in *Terebratulæ*. 4. Carstone, a yellow, coarse, sandy deposit, resting on a bed of clay, containing no fossils in its upper part, but with a band of nodules containing *Ammonites Deshayesii* and other species about thirty feet down, together with ironstone nodules like those of the Lower Greensand of the Isle of Wight, and bearing impressions of fossils which correlate the lower part of the Carstone with the base of the English Lower Greensand. The author gave a list of these fossils, and also of those of the Red Chalk, the latter amounting to sixty-one, and presenting a mixture of forms belonging to the Lower Chalk, Upper Greensand, and Gault. On comparison with the Gault section at Folkestone, the author considered it evident that the Red Chalk of Hunstanton was equivalent to the upper part of that formation. He mentioned that ten miles south of Hunstanton, in artificial sections, blue Gault has been found resting upon the Carstone, whilst rather nearer to Hunstanton the same place was occupied by a red clay, connecting the two dissimilar deposits, which, however, were shown by analysis to contain nearly equal quantities of iron. If the Upper Greensand be represented in the Hunstanton section, the author considered that its place must be in the band numbered 2, containing *Siphonia paradoxica* and *Avicula gryphæoides.*

DISCUSSION.—The President remarked that the vertebræ from the Red Chalk, noticed and exhibited by Mr. Wiltshire, were undoubtedly those of *Plesiosaurus latispinus* of the Upper Greensand, but associated with these were other bones which he could not identify with any part of the skeleton of *Plesiosaurus.*

Mr. Etheridge spoke in confirmation of the author's views, referring especially to the Palæontological evidence.

Mr. S. Hughes mentioned a boring near Hitchin where a hard sandstone, resembling Carstone, was found immediately below the Gault, the latter having a thickness of 280 feet.

Mr. David Forbes remarked on the similarity in the amount of iron present in rocks so dissimilar as the Red Chalk and the blue clay of the Gault.

Prof. Morris noticed the similarity of the Carstone of Hunstanton, and its equivalent beds, to the Hilsthon and Hilsconglomerat, especially in their containing abundance of pisolitic iron-ore. He then adverted to the marked difference of the Lower Greensand of the Midland districts from that of the southern and northern areas in England, in which that formation is developed,—the southern exhibiting the entire series of deposits, which seem to reappear in the northern area, while in the Midland district the lower members have not been observed.

Mr. Judd remarked that the conditions of deposition in the north and south had been different; the Red Chalk increases northwards, from 4 feet at Hunstanton to 30 feet at Speeton. He considered that the Carstone does not represent the Tealby series of Lincolnshire, and that it is probably Aptien or Upper Neocomian, but containing in its lowest part fossils derived from the disintegration of Lower Neocomian beds, in the same manner as the deposits of phosphatic nodules at Potton and Upware.

Mr. Whitaker objected to the use of chemical characters in the identification of beds, and thought that the presence of the same fossils did not necessarily prove the identity of the Red Chalk and the Gault.

Mr. Wiltshire, in reply, maintained the sufficiency of the Palæontological evidence, that furnished by the species of *Ammonites* being especially remarkable.

EDINBURGH GEOLOGICAL SOCIETY.—I. The third ordinary meeting of this Society was held on the 17th December, 1868; Archibald Geikie, Esq., F.R.S., etc., in the chair.

The following communications were read:—

1. "Notes on some Fossils from the Oolite of Yorkshire." By James Gowans, Vice-President. Mr. Gowans described some Fossils found by him at Lethrington Howe, near New Malton.

2. "Remarks on a specimen of *Ascoceras* from the Coal-measures." By George Lyon.

Mr. Lyon exhibited and described a magnificent specimen of *Ascoceras* from the Coal-measures of Lanarkshire. He pointed out that the discovery was of great interest, because hitherto this genus had only been been found in Silurian rocks. He made a few observations on the family *Orthoceratidæ.*

Dr. Page remarked that the *Ascoceras* just described by Mr. Lyon was the third perfect specimen he knew of that had been found in the Lanarkshire Coal-measures.

3. "Notice of columnar Mica-schist from a Vitrified Fort in the Kyles of Bute." By J. Haswell, M.A.

After describing the appearance of this Vitrified Fort, and the various theories advanced by different authors to account for the formation of such forts in early times, Mr. Haswell noticed the changes which had taken place in the Mica-schist, in consequence of the great heat to which it had been subjected; and he shewed, by adducing examples of columnar structure in other substances, that the columns in this Mica-schist have probably owed their origin to the subsequent contraction of the mass.

4. A beautiful "Nautilus" from the Carboniferous Limestone of Bathgate was exhibited by Alexander Somervail. It is thought that this specimen may turn out to be a new species.

II.—The fourth ordinary meeting of this Society was held on the 21st January, in the Society's rooms, Archibald Geikie, Esq., F.R.S., President, in the chair.

Mr. Geikie gave a Sketch of the Life and Works of the late Principal Forbes.

James David Forbes was born at Edinburgh, on the 20th April, 1809. He died on the 31st of December, 1868. When a youth, Principal Forbes studied geology under Jameson, from whom he acquired a love for mineralogy, and retained it to the last. Moreover, his own predominant tendency towards physics tinged even his geological studies. Hence we find him rising, on the one hand, from a contemplation of the phenomena of glaciers to a philosophical investigation of the laws under which these phenomena occur; on the other, from the mere observation and collection of rocks and minerals, to the natural philosophy of the operations by which they were produced. He attended the classes of the Edinburgh University. On leaving college, his favourite pursuits, as he tells us, were geology, meteorology, and general and terrestrial physics. He made excursions in his own country, and extended his summer rambles into the Continent, and particularly to Switzerland, where he formed friendships with some of the foremost scientific men of that country, and where the idea of investigating the natural history of glaciers early began to form itself in his mind. In the year 1833, when only twenty-four years of age, he was appointed to the chair of natural history in his own University, an office which he held with distinction up to 1859. No one who had the good fortune to hear his prelections will be likely to forget the singular clearness, patience, and thoroughness of his expositions. With his students he was a favourite professor. In addition to his labour in the University, he was indefatigable in attention to the welfare of the Royal Society of Edinburgh, of which he continued to be for many years the active general secretary. He communicated papers which shed a new lustre upon the transactions of that body, eliciting for their author the highest honours which the Society had to bestow, and giving him a name honoured and familiar throughout Europe.

When the duties of the winter were over, he loved to escape to

Switzerland, there to renew his researches among the snowfields and glaciers. He had early in life proposed to himself to examine that country, not as a mere amusement, but as a serious occupation, and with the great De Saussure as his model. Writing in 1843, he says of himself—"I had the advantage of receiving my first impressions of Switzerland in early youth, and I have carefully refreshed and strengthened them by successive visits to almost every district of the Alps between Provence and Austria. I have crossed the principal chain of the Alps twenty-seven times, generally on foot, by twenty-three different passes, and have, of course, intersected the lateral chains in very many directions. I have likewise undertaken similar journeys in other mountainous countries with a view to compare the results. I have spent part of ten summers on the Continent, and six of these in the Alps and adjacent country." From these varied wanderings, but more especially from the careful, detailed measurements made during a prolonged sojourn among the Swiss mountains in the summer of 1842, he was enabled to write his great work on the Alps—a treatise which at once established his name as an observant and eloquent traveller, and as the most successful of all the philosophers who had, up to that time, grappled with the problem of glacier-motion. The publication of his volume, however, by no means completed his labours. Year after year he continued to revisit the Alps, and to send at intervals a narrative of his arduous journeys to the *Edinburgh Philosophical Journal.* There is reason, indeed, to believe that the excessive fatigue of many of these mountain expeditions began to tell upon his constitution. In 1843, after the publication of his "Travels," he had an attack of inflammation of the lungs, and from that time forward he never possessed the same vigour as before.

In the year 1845 he visited the Isle of Skye, and his eye, already trained to recognise the traces of vanished glaciers in Switzerland, was at once struck by the identity of the forms assumed by the rocks at Loch Scavaig with the *roches montonneés* of the Alps. Further investigation led him to obtain complete demonstration of the former presence of a group of glaciers descending from the rugged scarps of the Cuchullin Hills. He walked over mountain and glen, filling in a rough sketch-map of the glacier valleys as he went along, and in December of the same year he read a narrative of his observations to the Royal Society of Edinburgh. This was the most detailed and satisfactory account which had yet been given of the proofs that the highlands of Britain once nourished groups of glaciers.

In the year 1851, as already remarked, Professor Forbes undertook a journey to Norway, partly to make observations of the great solar eclipse, and partly drawn by his love of physical geography, and notably of glaciers. It was his design to compare the phenomena of glaciers in Northern Europe with those already so familiar to him in Switzerland. This he has done in a masterly way. His pages contain, in a clear and succinct form, the sum of all that was known at the time regarding the snow line and the existing glaciers of Norway.

In December, 1859, on the removal of Sir David Brewster to Edinburgh, Professor Forbes was chosen Principal of the United College of St. Salvador and St. Leonard. in the University of St. Andrews. This office he held until his death, which took place on the 31st of December last. He slowly declined from an irremediable disease of the right lung.

The society then proceeded to the consideration of ordinary business.

The following communications were read:—

1. "On the Depth of the Seas in which the Carboniferous Limestone was formed." By Alexander Somervail.

Mr. Somervail said that by a careful study of the extent and thickness of the Carboniferous Limestone, the organic remains with which it is replete, and with what we already know regarding the bathymetrical distribution of life in our present ocean, and the deposits taking place over its bed, we might form something like a correct estimate of the comparative depth of those primeval seas. He mentioned that the late Professor E. Forbes held the opinion that the Carboniferous Limestone had been formed in shallow seas not exceeding fifty fathoms in depth, being led to the conclusion by certain mollusca of that period still retaining their colour markings, and by observing that the testacea of our present seas, which have colours and well-defined patterns, seldom inhabit greater depths than fifty fathoms. He differed from this conclusion of Professor Forbes, stating that the shells from the Carboniferous Limestone exhibiting patterns of their colours belonged to *few* individuals, and were confined to a few genera, such as Terebratula, Aviculopecten, Natica, etc.; moreover, they could not be proved to have remained in the original habitat in which they lived when imbedded in the calcareous mud, but may have been drift shells carried far from their own zones of depth. He remarked that the inference of Professor Forbes was still further invalidated by the fact that shells shewing distinct colours have been obtained from our present seas at depths of one hundred fathoms and upwards. He then proceeded to show that from the great extent and thickness of the Carboniferous Limestone, the thorough marine character of its fauna, and the total absence of land animals. and plants, that it must have been formed under deep water, far from the shore, and little influenced by rivers carrying sand and gravel, or the remains of plants or other land organisms, which characterise the deposits of shallow seas. He next alluded to the bathymetrical distribution of life in our present ocean—the great depths from which living animals have been obtained—and argued that the fauna of the Carboniferous Limestone seas had as great a range in depth, and that the limestone which is made up of their bodies or skeletons had been formed at depths as great. He concluded by observing that instead of fixing fifty fathoms as the maximum depth of the Carboniferous Limestone seas, he should be rather inclined to regard this as the minimum depth, while the maximum might be one thousand fathoms or even greater. This he considered no exaggeration, but to be borne out by all the phenomena presented by the Carboniferous Limestone, and by the deposits at present forming over the bed of the ocean.

2. "Notice of Certain Concretions found in the Upper Silurian Rocks of Denbighshire, North Wales." By David W. Roberts. Mr. Roberts found, on examining several hundred specimens of these concretions, that they contained the remains of Graptolites, Encrinites, Orthoceras, and some bivalves, among which may be noted Pentamerus, etc. In most cases the remains had been converted into a metallic oxide. These concretions are often heart-shaped, frequently oval or oblong, and rarely globular. Their long axis, as a rule, is found on the same plane as the line of deposition of the strata. The walls of the cavity are composed of a hard but friable slate. Some of them are soft internally and hard externally; others soft externally, but having a nucleus of flinty hardness.

3. "On some Beds of Recent Fossiliferous Sandstone and Clay at Granton, with illustrative specimens." By John Henderson. Mr. Henderson discovered this recent fossiliferous clay and sandstone formation some years ago at Granton. The locality where this deposit is found lies to the west of Granton Quarry. He described it as a series of thin bedded clays, extending along the whole length of the bay in front of Granton House. These clays, he believed, had evidently been deposited at a comparatively recent period, in a hollow scooped out of the Carboniferous shales overlying the Granton sandstones, and yielding numerous shells common in the Firth of Forth at the present day. These were in a completely fossilised state, imbedded in a hard and compact sandstone. The clays, so far as had already been examined, contained seven species of recent entomostraca, as well as several species of foraminifera.

4. "Notice of Sandstone now in Course of Formation at Elie, Fifeshire." By James Haswell, M.A. The sandstone in question occurred at a point in the section of the Carboniferous strata between Elie and St. Monance, near the railway bridge at Ardross. Resting upon the Carboniferous strata, was a bed of tenacious clay containing recent shells, above which was blown sand, which was washed down by the rain over the clay, and deposited in ledges formed by the projecting beds of shale, while the siliceous particles of which the sand was composed were cemented together, partly by carbonate of lime held in solution by the rain water, and derived from the shells occurring in the sand and in the clay, and partly from a ferruginous cementing material contained in the latter. A hard sandstone was being formed, not unlike one of much older date, in some places enclosing one or two recent shells, thus making the resemblance more complete.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.—Ordinary Meeting, December 1st, 1868. R. Angus Smith, Ph. D., F.R.S., Vice-President, in the chair.

"Note on Professor Williamson's paper 'On an Undescribed Type of *Calamodendron* from the Upper Coal-measures of Lancashire,'" by E. W. Binney, F.R.S., F.G.S.

Mr. Binney considers the plant described by Prof. Williamson as very different from the *Calamodendron commune* described by him in the last volume published by the Palæontographical Society. He had found casts of the pith of the *Sigillaria vascularis* which ordinary collectors would call a *Calamite,* and in two specimens of *Dadoxylon* he has met with *Calamites connæformis* as the pith of one, and *C. approximatus* as the pith of the other. *Sternbergia* has long been known to be the pith of *Dadoxylon,* so now the genus *Calamites* in all probability will have to be very considerably modified and some of its species classed with other genera.

"The Hematite Iron Ore Deposits of Whitehaven: Notes on the Aldby Limestone, Cleator Moor," by W. Brockbank, F.G.S.

The mountain limestone of the Cleator district forms an escarpment to the valley of the river Eden, from Egremont round the base of Dent Fell, towards Cockermouth. It rests upon the old clay-slate of Skiddaw and Dent, and is the outcrop of the Whitehaven coal field. It contains most extensive and valuable deposits of hematite iron ore. The easterly side of this large limestone surface is deeply fissured in every direction, and when the crevices are not filled with till, they are found to contain hematite ore. The escarpment sloping towards the river Eden is made up of breccia of hematite ore and limestone, in large irregular blocks, cemented together into a compact mass. It is so rich with ore at the surface, as to be worth working, and an open quarry was commenced, and a large quantity removed, but the impurity of the product soon led to its abandonment. It is very evident that this face of limestone was at one period covered with a large deposit of hematite ore, since denuded.

CORRESPONDENCE.

ON DENUDATION, AND THE CRAGS.

Sir,—Colonel Greenwood's letter can hardly be considered a reply to my views, because he does not meet my difficulties. Arrayed in seven-leagued boots, he plants one foot in Norfolk, and the other in the valley of the Amazon, and in two sentences fights the battle of denudation over half the globe. But controversy is not my object. I see many appearances which favour the rain theory, and admit that it can explain many facts, and I believe that what Colonel Greenwood says about the migrations of soil is, under present circumstances, quite correct. But although pluvial denudation is now going on here, it is not so everywhere—not so, for instance, in Greenland, nor on the Antarctic continent. Are we sure that what is now the case in Greenland was not the case in this and in many other countries, when the present surface was shaped? I see indications which lead me to suspect such to have been the case. What interpretation does Colonel Greenwood put upon them?

If, instead of reasserting his opinions, which are already sufficiently strongly stated in his very amusing book, he will come down to details, and meet the difficulties which I have pointed out, he may, if he thinks it worth while, convert me and perhaps some others. Particularly I would ask him to explain how the basins containing the "meres" and "broads" of Norfolk can have been formed by rain; and, more generally, the condition of the subsoil which I have described under the name of "Trail." Col. Greenwood has not appreciated the point I endeavoured to raise respecting the windings of the valley (I must not say of, but) in which the Bure runs; nor yet has he *explained* the degradation of Lopham ford, but only asserted that it is due to pluvial denudation.

And now, with respect to Mr. Lankester's remarks upon the Crag and its mammalia, I must re-state that it was solely on Mr. Gunn's published authority that I referred *Elephas meridionalis* to the Red Crag. Mr. Whincopp's fine collection does not contain it, unless a piece of ivory may be considered a presumption in its favour. The species, however, is abundant in the Norwich Crag, which is sufficient for my argument. The other species mentioned by Mr. Lankester are, I believe, very rare in the Red Crag, and derivative.

Much remains to be done before it can be decided whether the two Crags in question are, or are not, of the same age. I incline certainly to the opinion that they are so; for they seem to pass gradually one into the other. In the central district of the Crags we find it under Chillesford church, having a close resemblance to the Red Crag at localities to the south, yet still not identical with it. Going on to Sudbourne, in the pit north of the church, and near the top of the hill, a Crag is seen resting on the Coralline, which has an intermediate character. At Thorpe, near Aldburgh, the type is decidedly that of the Norwich Crag.

Something might, perhaps, be learnt from digging at Thorpe, were it not for the water. There the Crag rests upon a sandy clay, which is neither Coralline Crag, Eocene, nor Chalk. So also at Wangford. I used to consider this the Chillesford Clay, but have been led to abandon that view. What is it?

The passage from the Red to the Norwich Crag seems to occur where the two provinces are separated by a ridge of the older Coralline. This may possibly have marked the boundary between two opposing currents, and may either have been due to diminished erosion at their confines, or may have acted as the cause of their demarcation. The current, sweeping up from the south over a bottom of London clay, would, on account of its warmth, contain a mixture of more southern contemporary forms, as seen at Walton-on-the-Naze, and would bring with it *derivata* from the London clay and Miocenes of the south, as in the Suffolk bone-bed; while the other from the north would contain a somewhat more arctic assemblage of species, with fewer and different derived fossils.

The phosphatic nodules. and many of the fossils of the Red Crag, come out of the London clay. Why should not its iron be derived from the pyrites so remarkably abundant in the same formation? An exception may be taken to prove the rule, for at Walton-on-the-Naze we have the Crag resting on the London clay, *but quietly deposited*, so that *Pectunculi* and *Pholades* are frequently found with their valves united, and the most delicate shells are unrolled. It is remarkable that at that place we have no extraneous fossils, very few phosphatic nodules, and very little iron oxide. This seems to show that Walton was within the influence of a warm current as to temperature (as shown by its species), but from some local cause escaped its eroding action (as shown by the conditions of deposition), and consequently did not receive the foreign bodies which would have required a swift stream to import.

O. Fisher.

Harlton, Near Cambridge.

ELEPHAS MERIDIONALIS IN THE RED CRAG.

Sir,—Mr. Lankester, in your last number, inquires "What grounds have the Rev. John Gunn and the Rev. O. Fisher for stating that the *E. meridionalis* is found in the Red Crag?" I reply that I saw a specimen—an old much water-worn molar—in the collection of Mr. J. H. Roper, of Lowestoff, Suffolk, merchant. It appeared to have been derived from an older, or basal portion of the Red Crag; and, if so, the *E. meridionalis* is referred back to at least the commencement of that crag, which admits, I believe, of several subdivisions. I quite agree with Mr Lankester that there is "no reason for believing that the specimen of *E. antiquus* mentioned in Palæont. Mon. Vol. II., p. 181, was derived from the Red Crag. Dr. Falconer says that it came from Southwold, where there is no Red Crag at all. A ridge of Coralline Crag at Aldburgh appears to separate the Red from the White Norwich Crag, and there is, as Mr. Prestwich maintains, no instance of superposition of those two crags. I may safely affirm that no specimens of the *Rhinoceros Schleiermacheri*, or *Hipparion*, have been found in Norfolk. Mr. R. Fitch has, I think, some of the *Hyæna antiqua* (?) The *Ursus arvernensis* (so named by M. Lartet) abounds in the Forest-bed, and also the *Rhinoceros Etruscus*. Having noticed the points of reference made to me, I might conclude; but on looking to the next page, I observe that Mr. Fisher is exposed to a raking fire from Colonel Greenwood. As I know that my friend is quite equal to self-defence, I will not further interfere in the fray than to ask how, if the erosion of the valley at Lopham be attributable to either pluvial or fluvial denudation, supposing the water-shed to have been ever on that spot, could the magnificent bed of valley gravel have been deposited on the bank near the ford and the water-shed. I should be glad to be instructed on this point. In a paper, which I read at the British Association at Norwich, I attributed the formation of the water-shed to an upheaval, which may be traced through Norfolk, and which brought the Chalk to the surface at Trimmingham, after it had dipped beneath the beach at Cromer. The river, I conceive, previous to that upheaval, had flowed to the east or to the west, and had deposited that valley gravel. How it came there under either Colonel Greenwood's or Mr. Fisher's hypothesis, I do not understand. I suppose that snow-falls are taken into account under pluvial action. The power of these during the Reindeer period must have been very great.—I am, etc.,

John Gunn.

Irstead Rectory, *Jan.* 19, 1869.

CORRECTION OF NOTICE IN FEBRUARY NUMBER.

SIR,—With regard to your Review of Dr. Buchanan's Report on Connection of Soil, etc., with Phthisis, p. 80, please make the following correction:

The information for the Geological description of the Wealden Districts was in great part supplied by my colleague Mr. W. Topley, F.G.S., as stated in Report. W. WHITAKER.

P.S.—*The Map of Terling* relates to Dr. Thorne's Report, not to Dr. Buchanan's, and has no connection with Phthisis. W. W.

MISCELLANEOUS.

◆

RELATION BETWEEN PALLADIUM AND HYDROGEN.—A paper bearing the above title was read at the Meeting of the Royal Society, on the 15th of January, by Thomas Graham, F.R.S., Master of the Mint. After a brief reference to the facts that had induced chemists to consider hydrogen to be metallic, the author reminded the Royal Society of his previous researches on the absorption of hydrogen by palladium, which metal "occludes" 980 volumes of the gas. This absorption is accompanied by an actual expansion of the *metal* to a greater extent than if heated to redness. Thus, a wire of palladium 609·14 millimetres long was expanded by 9·77 millimetres, or 1·6 per cent. The density of the wire being known, it was easy to calculate the sp. gr. of the occluded hydrogen, the result arrived at being that the condensed gas was nearly double the density of water or 1·98. Mr. Graham, therefore, considers the hydrogen to be present as the metal Hydrogen*ium* in alloy with the palladium, and this view was supported by the magnetic state of the alloy, its tensile strength and electric conductivity. In concluding his paper, Professor Graham paid a very high compliment to his Assistant Mr. W. Chandler Roberts, for his valuable co-operation.

AWARD OF THE WOLLASTON MEDAL AND DONATION FUND.—At the Anniversary Meeting of the GEOLOGICAL SOCIETY OF LONDON, February 19th, 1869, the President, PROF. T. H. HUXLEY, F.R.S., etc., announced that the Council had decided to award the Wollaston Gold Medal to HENRY CLIFTON SORBY, ESQ., F.R.S., F.G.S., etc., for his researches in the structure of Rocks and Meteorites by Microscopic and Spectroscopic examination, and for his demonstration of the laws of Slaty Cleavage. The President further announced that the proceeds of the Wollaston Donation Fund had been awarded to WILLIAM CARRUTHERS, Esq., F.L.S., F.G.S., for his researches in Fossil Botany. As many of Mr. Carruthers' articles have appeared in the GEOLOGICAL MAGAZINE, its readers will have had the opportunity of appreciating the value of his admirable labours in this neglected field of palæontological inquiry.

THE
GEOLOGICAL MAGAZINE.

No. LVIII.—APRIL, 1869.

ORIGINAL ARTICLES.

I.—On the Supposed Internal Fluidity of the Earth.

By G. Poulett Scrope, Esq., F.R.S., F.G.S.

[Second Notice].

IN his recent volume on "Vesuvius," Professor Phillips has added the weight of his great authority to the popular opinion as to the complete internal fluidity of the globe. It may not, therefore, be out of place to examine very shortly the chief argument which appears to have led him to adopt this view, and to discredit that advocated in my paper in your December number, namely, that "pressure, by raising the temperature of fusion" in the matter immediately beneath the exterior crust, probably prevents its liquefaction; in other words, maintains it in a solid state, except where some upheaval of the surface rocks, or the production of some deeply penetrating fissure, has by a sudden reduction of pressure admitted of its local liquefaction.

The Professor opposes to this view the consideration that, "according to all analogy, pressure must rise (downwards) in a higher ratio than temperature in order to prevent solidification; and as both temperature and pressure must rise in arithmetical progression (at such depths as we are now considering) it is most probable that liquefaction can only be prevented in a slight degree by pressure; very possibly it is not prevented at all." (Vesuvius, p. 329.) Now it is evident that this argument rests on the assumption that the pressure to which any interior liquid mass is subjected, consists of the force of gravity alone, and (as I urged in my last paper) ignores the increased pressure arising necessarily "from the tendency to expansion of every part caused by its extreme heat, whether in a solid, liquid, or gaseous state—more particularly if, as there is reason to believe, the subterranean matter is intimately permeated with water, itself occasionally solidified by pressure, but yet retaining its intense expansibility." Surely this vast elastic force, resisted in its action by the weight, cohesion, and perhaps increasing contraction of the solid crust above, may well be supposed to augment the pressure on every part so far as to turn the balance in favour of solidification.

The ideas of those who advocate the fluidity of the interior of the globe, seem to be very vague as to the meaning they attach to the word 'fluidity.' Some, like Mr. Hopkins, have used the phrase in its strict mathematical sense, excluding all consideration of internal friction—a sense utterly inconsistent with any conceivable condition of fused rock. Others seem to have had in their minds a degree of fluidity which would allow the matter always to find its own level, and yield to pressure by moving in the direction of least resistance with the facility of water in a siphon. A reviewer of Professor Phillips's work in the *Pall Mall Gazette* of March 10th, even asserts unhesitatingly that Palmieri's novel and recent observations on the seemingly *tidal* influence of the sun and moon upon the activity of a volcano in eruption, prove that "the lava ocean under Vesuvius must be enormous and comparable in size to the Atlantic or Pacific," because "tidal influence only produces appreciable effect on the largest sheets of water." Surely there is no need of such an assumption. If Professor Palmieri's idea of the tidal influence of the attraction of the sun and moon on volcanic activity—in itself extremely probable—be shown by further observations to be correct, it will only amount to a corroboration of that which many years since I put forward (and which Sir C. Lyell has adopted) as to the similar influence of varying barometric pressure on the action of Stromboli and other volcanos, whose lava ducts are at the time in open communication with the atmosphere. The elasticity of the steam and other gases contained within or beneath the lava, seizes the opportunity for expansion afforded by diminished atmospheric weight in this case, just as the tidal wave rises through the lateral pressure of the surrounding oceanic waters, when its own gravity is reduced by the moon's attraction. In the case of the volcano, there is evidently no need to imagine any lateral movement of highly liquid lava towards the vent, to account for slightly increased flows of lava, or steam explosions at the tidal periods. Nothing, therefore, in M. Palmieri's observations tends to support the hypothesis of the existence of vast oceans, still less of a continuous belt, of fluid matter, beneath the earth's crust—in itself, as I have shown, an improbable supposition.

Many facts tend to show that "lava," the only fused rocky matter in nature with which we are acquainted, is, when it issues from the interior of the earth during volcanic eruptions, extremely viscous; and though some currents are seen to flow down an incline so low as 6° or 8° with a velocity of three or four miles an hour, others are so sluggish as to accumulate in bulky masses beside or over the orifice whence they are expelled. If it be suggested that in the depths of the volcano the fluidity of the lava is probably very much greater, owing to its higher temperature, this idea is, I think, inconsistent with many well-known facts, such, for example, as the occasional efflux of liquid lava from the summit of Mauna Lòa in Hawaii, while that in the crater of Kilauea at a level of 10,000 feet lower, and only 16 miles distant, remains unaffected. So, also, M. Deville saw on the summit of Vesuvius, in 1856, two closely adjoining minor craters, in one of which a pool of incandescent lava bubbled up, while the bottom of the other, at a lower level by 300 feet, remained empty (see Volcanos, p. 261). Such facts as these have brought me to the conviction that though there may be occasionally lateral flows of lava beneath the surface of a volcano, from an interior pool, through fissures opening outwards at a lower level —as in the *tappings* of the lake of Kilauea, so frequently witnessed —yet, in general, lava solidifies so rapidly and readily from increase of pressure or diminution of temperature, that no very extensive accumulations of such matter in a fluid state are likely to exist even beneath an active volcano, still less below vaster areas of the earth's crust, and that the apparent connection of one volcanic vent with others in its neighbourhood, or belonging to the same chain, is rather due to the lateral transmission or escape of heat than to the actual transference of liquid matter between one and the other. This is the leading idea which I have ventured to enounce in the work on volcanos so often referred to; and it is, I believe, perfectly consistent with all that we know of the phenomena of occasional local excitement and intermittence in the volcanic subterranean forces. It is an attractive sensational idea—that of a molten interior to the globe underlying a thin superficial crust, its surface agitated by tidal waves and flowing freely towards any issue that may be here and there opened for its escape; but I do not think it can be supported by any sound argument based on ascertained facts or phenomena, and I prefer the supposition that the interior of the globe, like its surface, is solid, except where local and temporary increase of heat or reduction of pressure have given occasion to the local liquefaction and partial outward discharge of the expanded matter—changes which may be attributed to the unequal escape of heat from the interior into outer space, both by radiation from a surface of ever-varying conductibility, and by direct expulsion through hot springs and volcanic vents.

FAIRLAWN, COBHAM,
March 13*th*, 1869.

II.—THE BRAZILIAN COAL FIELDS.

By NATHANIEL PLANT, F.R.G.S., F.G.S., etc.

With a Description of the Plant-Remains, etc., by W. CARRUTHERS, F.L.S., F.G.S., of the British Museum.

THE presence of Coal-beds in South America has been known for several years, but the only localities on this side between the Amazon and the River Plate where their existence has been actually determined, are in the two extreme southern provinces of Brazil, Rio Grande do Sul, and in the adjoining one of Santa Catherina, and in the neighbouring Republic of Banda Oriental or Uruguay.

Lignite, brown-coal, and bituminous schists occur in thin beds along the coast and in the interior of Maranham and Minas Geraes; but it is only in these three southern provinces that true Carboniferous rocks containing palæozoic fossils have hitherto been discovered; nor should I think it likely, from the observations I have made in nearly every province in the Brazilian Empire and the Republics of the River Plate, that true Carboniferous rocks will ever be found north of the province of Santa Catherina, unless it be in the adjoining one of Parana (lat. 25° S.)

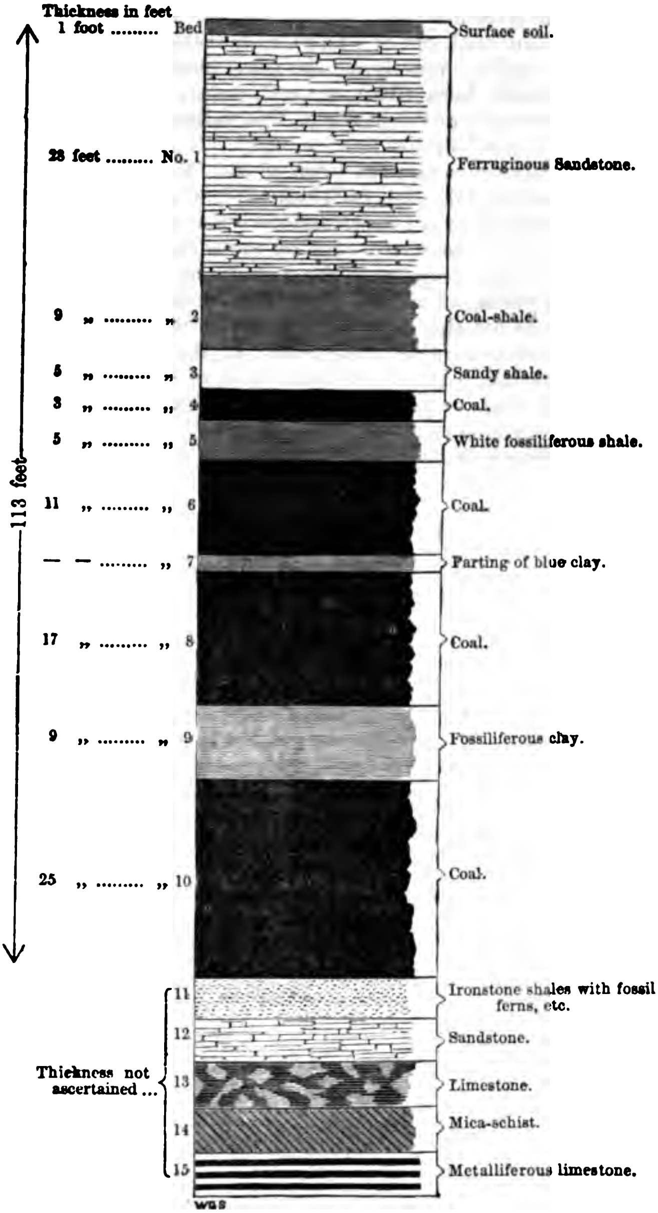
The province of Rio Grande do Sul contains three distinct Coal-basins, all of which I have examined, and ascertained, in some degree, the extent and thickness of the Coal-strata. They are all contained within the limits of lat. 30° and 32° S., long. 51° and 54° N., and are separated from each other by rolling hills of granite, syenite, mica-schist, and trachytic and basaltic rocks. The largest of these deposits is, perhaps, the one occupying the valleys of the rivers Jaguarão and Candiota between lat. 31° and 32°, long. 53° and 54°. The sedimentary rocks forming this basin have an uniform inclination of 10° to 15° towards the south, and apparently rest upon the mica-schist and sienitic rocks which enclose the valley of the river Jaguarão and its confluents. The falling away of one side of a hill in this basin, near its basset-edge, on the banks of the Candiota, laid bare the strata to a considerable depth, disclosing five distinct beds of bituminous coal ranging in thickness from 9 feet to 25 feet, giving 65 feet as the total thickness of the coal exposed. The accompanying Section will show the order of superposition and thickness of the different beds as they appear on the face of the escarpment.

The *Sandstone* (No. 1) is evidently the uppermost rock, and forms two ranges of hills, one dividing the waters of the Jaguarão from those of the Candiota, and the other separating the tributaries of the Candiota from those of the Jaguarão-chico. The thickness of this bed varies considerably, being in some parts completely worn away, and in others attaining a depth of upwards of 200 feet. It contains nodules of argillaceous peroxide of iron. Immediately below this sandstone is found the first seam of coal-shale, 9 feet thick, which can be traced wherever the superincumbent sandstone has been denuded, for about 50 miles along a line running N.E.–S.W., and for about 30 from N.W.–S.E. Below this is a bed of sandy-shale, three feet in thickness, containing ochreous oxide of iron in the form of septaria; this overlies a bed of semi-bituminous coal (No. 4) which rests upon a thin seam of whitish clay, below which is another bed of coal, separated by a thin bed of blue clay (No. 7) from coal of a highly bituminous nature and possessing a thickness of 17 feet; this again is divided by a parting of clay similar to No. 7, from a bed of coal containing bands of Cannel-coal, having a thickness of 25 feet and very bituminous.

Impressions of palæozoic plants occur in this bed and in the ironstone shale (No. 11) upon which it rests. The thickness of this ironstone I have not been able to ascertain; but it evidently rests upon sandstone (No. 12), which is similar in every respect to the upper bed of sandstone. This is the lowest bed shown in the escarpment; but from observations which I took in another part I found that this sandstone (No. 12) rested upon beds of limestone, which in some places appear to be separated by mica-schist.

The Carboniferous rocks of this basin have apparently been but

NATURAL SECTION OF BEDS SEEN IN THE ESCARPMENT AT THE "SERRA PARTIDA," RIVER CANDIOTA.



little disturbed by eruptive rocks, although basaltic dykes of considerable width are evident in the surrounding schistose and syenitic hills.

The second basin lies in the valley of the São Sepé, one of the tributaries of the river Jacuahy, in about lat. 30° 20′, long. 53° 30′. Two distinct beds of coal, one of 7 feet and the other of 14 feet thick, appear in this locality underlying the same sandstone beds, which in some places have been tilted up and overflowed by trachytic dykes. The Carboniferous deposits in this valley have been traced over an area of about 15 miles.

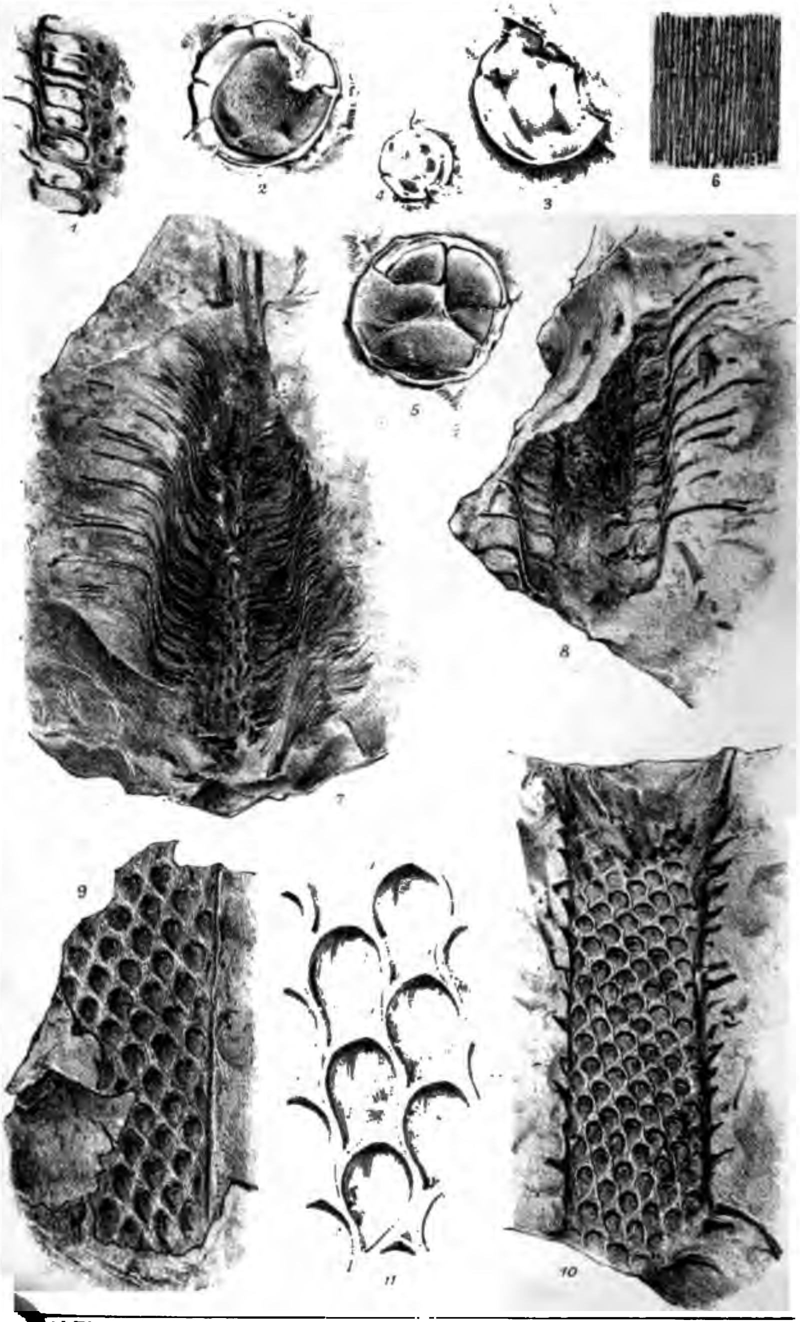
The third coal-basin is near the town of the Sao Jeronymo, on the banks of the river Jacuahy, lat. 30°, long. 51° 30′. The coal in this place is being worked by a Lancashire coal-viewer, Mr. James Johnson. The sections of two shafts sunk on the edge of the basin shew a superposition of rocks similar to the deposits on the Candiota. At the depth of 19 yards, a bed of highly bituminous coal 6 feet thick was met with; below this is a bed of iron-stone shale containing fossils of the same genera as those found in the beds at Candiota. The shafts have been carried on to a depth of 61 yards, passing through beds of coal varying in thickness from 2 feet to 6 feet, interstratified with blue clay and ironstone.

The Carboniferous deposits in the province of Santa Catherina are situated in the southern extremity in lat. 28½°, long. 48° 14′ to 48° 44′. About 45 miles N.W. of the sea-port of Lagana the basin is intersected by the river Tubarão and its tributaries. By driving levels and sinking pits, five beds of coal of a thickness varying from one and a half feet to ten feet, have been met with, underlying a sandstone formation. An analysis of specimens from these beds, made by Professor Thomas Richardson, gave the following results:—

Spec. No. 1.		Spec. No. 2.		
37·67	...	35·42	...	Fixed Carbon.
18·33	...	21·10	...	Gaseous Matter.
44·00	...	43·48	...	Ash.

The specimens were taken from near the outcrop.

In the Republic of Banda Oriental or Uruguay Carboniferous beds similar to the above, and underlying sandstone of the same character as that found above the coal-beds I have described, can be traced for many miles on the head waters of the Rio Negro, between lat. 31° and 32°, long. 54° and 55°. Here the sedimentary rocks have undergone considerable displacement from the eruption of the trachytic rocks which characterize the surrounding country. South of this district, as far as the river Plate, no sedimentary rocks occur, except along the banks of the river Uruguay, where limestones are found. In Paraguay, on the head waters of the Tibicuari, I observed the same Sandstone formation, with beds of coal-shale, as that seen in Rio Grande do Sul and S. Catherina.



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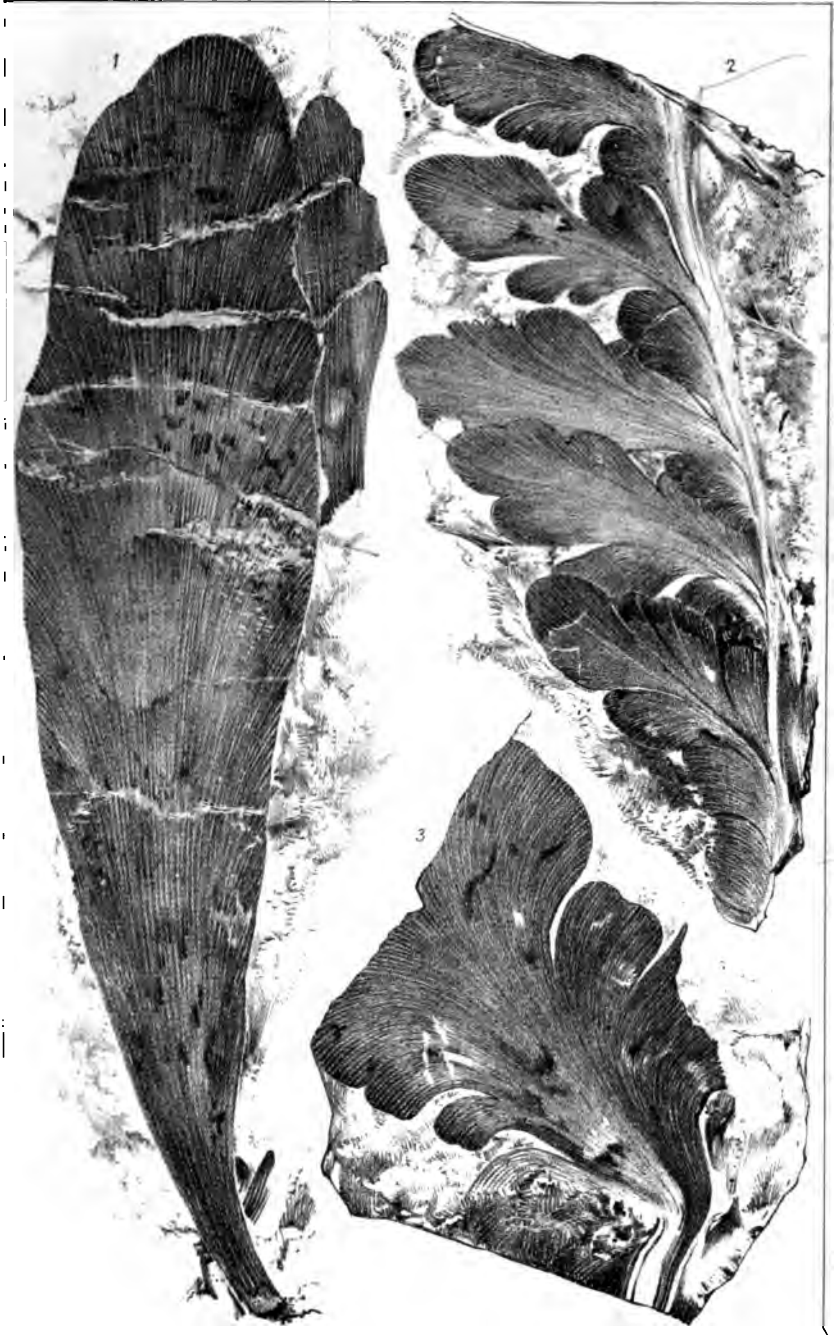
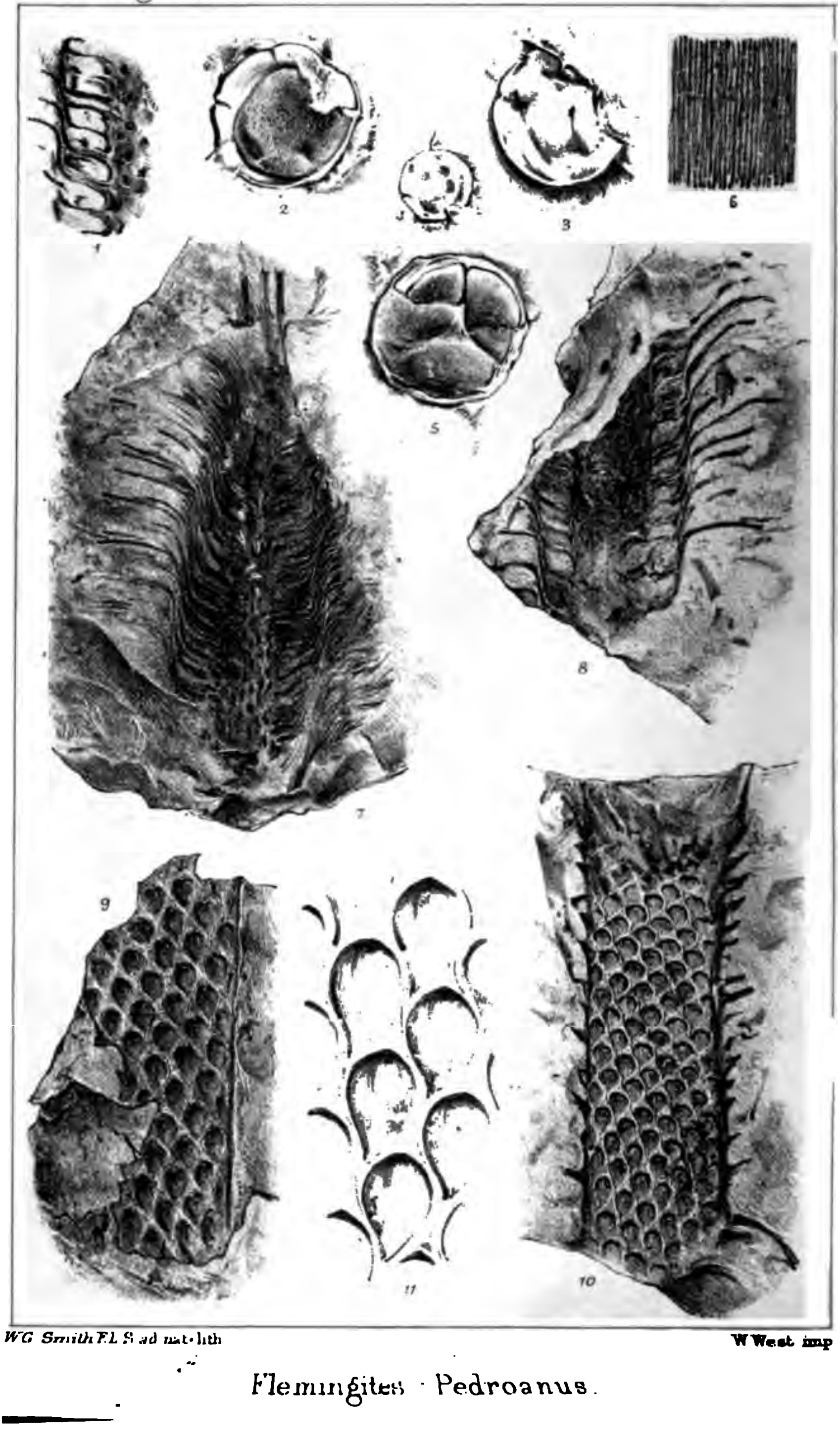
Flemingites Pedroanus

Geol Mag. 1869. Vol VI Pl VI.



W G Smith F.L.S ad nat lith.

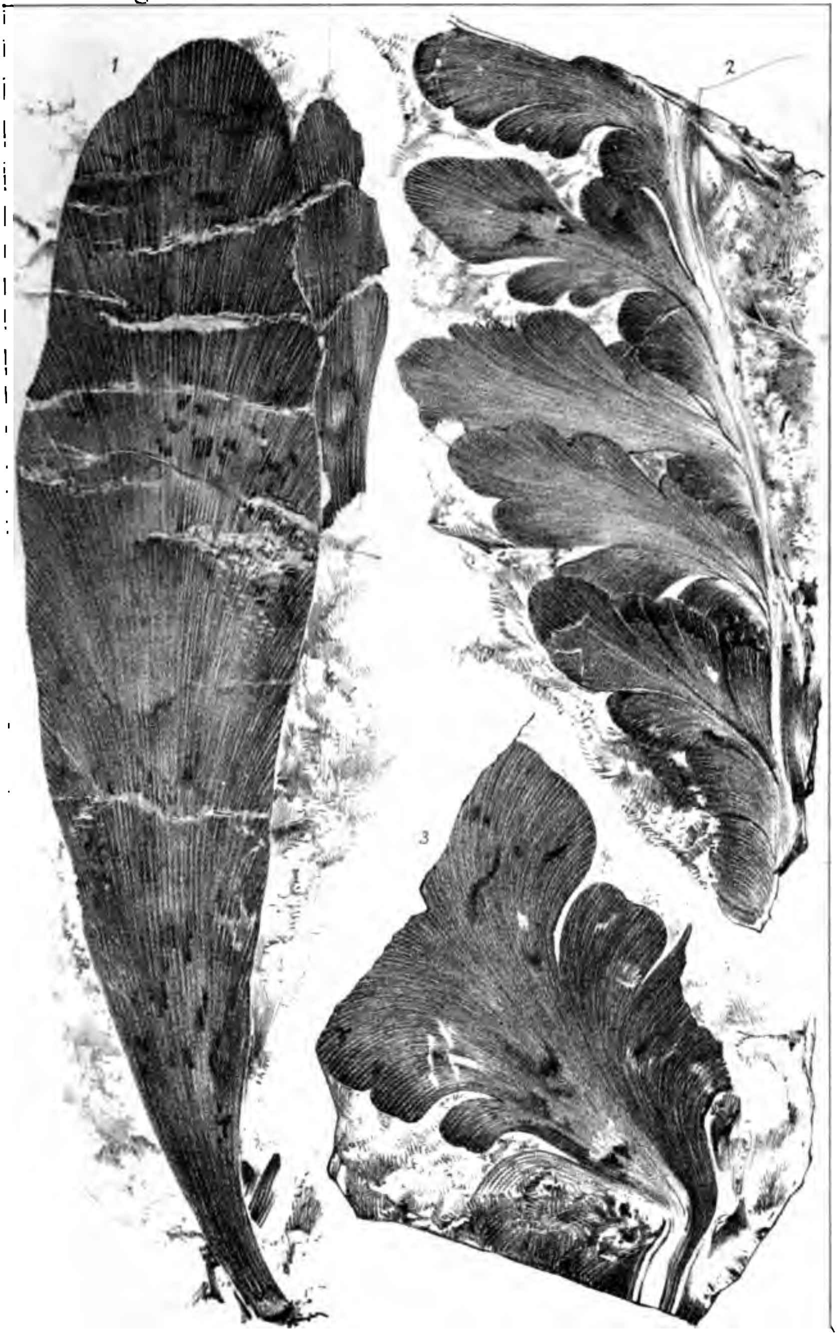
1 *Noeggerathia obovata* 2. Odontopteris Plant



W.G. Smith F.L.S. ad nat. lith
W West imp

Flemingites Pedroanus.

Geol Mag 1869.   Vol VI Pl VI.



W. G. Smith F.L.S. ad nat. lith.   W. West imp.

1 *Noeggerathia obovata* 2. Odontopteris Plantiana

III.—On the Plant Remains from the Brazilian Coal Beds, with Remarks on the Genus *Flemingites.*

By W. Carruthers, F.L.S., F.G.S.

(PLATES V. and VI.)

THE specimens placed in my hands by Mr. N. Plant from Rio Grande do Sul consist of a few specimens of coal and a considerable number of a highly ferruginous shale. The coal contains no recognizable fossils, but they abound in the shale. The substance of the plants is converted into a brittle coal, that possesses no structure, and exhibits the form only of the organism, but the superficial structure and the venation is often so beautifully preserved on the surface of the shale, when the coal is removed, that the nature of the fossils is very clearly exhibited. I have, thus, been able to determine with precision three species, and to recognise more vaguely a number of other forms, which, however, it would be injudicious, until additional material is obtained, to name or describe from the specimens in my possession. All these forms, as far as they can be determined, and certainly the three well-preserved species, belong to Palæozoic genera, species of which occur in the Coal-measures of Britain. We are thus enabled with certainty to refer the Coal-fields of the province of Rio Grande do Sul to the Carboniferous period, although the coal itself has more the aspect of being the product of a Secondary formation.

The three species which I propose describing in this paper are new forms belonging to the genera *Flemingites*, *Odontopteris*, and *Noeggerathia*. The most interesting of the three is the species of *Flemingites*, of which there are a large series of specimens of the stems and foliage, as well as of the detached sporangia. The characters of the species are as follows:—

Flemingites Pedroanus, sp. nov. Stem lepidendroid, scars small, obovate, without any markings; base of the petiole permanently attached to the stem; leaf slender, linear; venation parallel. Fruit a cone (?) the scales of which support numerous roundish sporangia.

I have, at the suggestion of Mr. Plant, associated with this interesting fossil the name of Dom Pedro II., Emperor of Brazil, who has on many occasions rendered such substantial aid to scientific investigators, as to have laid students of science under a debt of gratitude to him.

Some years ago (Geol. Mag. Vol. II. p. 433) I established the genus *Flemingites* on the fragment of a cone which exhibited the relation of the small round sporangia so abundant in many coal-beds to their supporting organisms. There were no indications, in the only specimen I then had, of the plant on which the cone was borne, though it was evident from the structure and arrangement of the parts that it was the fruit of a form of *Lepidodendron*. I have since seen more perfect specimens from Burdie House in the collection of the British Museum, and from the Newcastle Coal-field belonging to Mr. J. Duff of Etherly. In my recent examination of the rich collection of Coal plants in the Newcastle Museum I found that the specimen figured in Lindley and Hutton's Fossil Flora, plate x. fig. 1, as a form of *Lepidostrobus variabilis* is really a specimen of *Flemingites gracilis*. In passing, I may say that this supposed species was made the receptacle for all indistinct and badly preserved specimens of such cones; the *variable* appearance of the specimens arising from their belonging to different species, and even, as it now appears, to different genera. In all the specimens, however, of *Flemingites* which I have examined I have seen no indication of the branch or tree on which they were supported, and the characters of the genus have been consequently confined to those of the cone. It is not a little interesting that the materials for completing our acquaintance with the fossil should be brought from South America,—a continent which, as far as I know, has not hitherto yielded any palæozoic fossil plants. The examination of the plate and of the description given will show, however, that the one organ wanting in the specimens from Brazil is the cone on which to a considerable extent I founded the genus. The sporangia abound, and though the co-relation of these organs with the lepidodendroid stem depends not upon direct observation but upon induction, yet that induction is so conclusive that it appears to me to place the matter beyond doubt.

The small round sporangia belong, as far is known either to *Sigillaria* or *Flemingites*. They abound in these Brazilian shales, and the only plants associated with them to which they could belong is that which is described in the diagnosis of the species. The arrangement of the leaf scars and the form of the leaf conclusively establish that this is not a *Sigillaria*. Among Mr. Plant's small collection there are over twelve different specimens of the stem, with numbers of sporangia scattered over the surface of the fragments on which they are preserved, and in one specimen several sporangia occur among the mass of true leaves which remain attached to the end of the branch, though not related to them as in the described cone of *Flemingites*.

The spiral arrangement of the leaves on these stems also agrees with the arrangement of the fruit-bearing leaves on the cone, so that there can be no doubt that the stems belong to *Flemingites*. They have the ordinary aspect of the stems of *Lepidodendron*, the scars being arranged in a spiral order. There are nevertheless points of considerable importance by which the two forms can be distinguished. The scars are small, approaching in size and form those of *Lycopodiolites cordatus*, Sternb. (Flora d. Vorwelt, tab. lvi. fig. 1), from Yarrow in Durham, a fossil which has been overlooked by subsequent authors, except that Professor Morris, who never overlooks anything, records it in his Catalogue of British Fossils under the name of *Lycopodites cordatus*. In the Brazilian fossil the scar is not *cordate*, but perfectly rounded on its upper margin (see enlarged scars, Pl. V. Fig. 11). But the most important character in respect of the scar is that it presents no impressions from an articulating surface like what is seen in *Lepidodendron*. This arises from the fact that the bases of the petioles permanently invested the stem, the leaves disarticulating at a line about a quarter of an inch along the petiole from the stem surface. A somewhat similar structure is described by Corda in his genus *Lomatophloyos*

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[1] Prof. Morris has shown me specimens of Corda's *L. crassicaule* from English strata, and I have a second species from the beds of volcanic ash in Arran to which I *have given the name of L. Wunschianus*, after my friend Mr. E. A. Wünsch, of

(Beitrage, p. 17).[1] In the only species described by Corda, *L. crassicaule*, the bases of the leaves are larger and proceed from the stems in a line having the same direction as that of the leaves, which are articulated to them. In these stems from Brazil, the permanent slender bases of petioles (Pl. V. Figs. 1, 7, 8), shortly after leaving the stem, take an ascending direction parallel to the surface of the stem, and pass somewhat over the base of the petiole above before the leaf is given off. In the fresh plant the imbricated petioles would give a continuous surface parallel to the circumference of the stem. Although this appearance is not exhibited in any of the specimens from Brazil, it is clearly shown in a species from Cape Breton Island, for which I am indebted to Mr. Edgecombe Chevallier. A specimen of the same species is figured by Geinitz under the all-absorbing name of *Lepidostrobus variabilis*, Lindl. (Versteinerungen, tab. ii. figs. 1, 3, 4). In these figures the stem is shown densely covered with the permanent petioles, and at B' fig. 1, the imbricated surface of the end of the petioles is shown, while at the margins of the specimen the relation of the leaves themselves to the petioles is also clearly shown. It would be rash to affirm that this structure is peculiar to the genus *Flemingites*, but future discoveries may show that it is.

In *Flemingites Pedroanus* the curve of the leaf is the reverse of that of the permanent petiole, being bent outwards and downwards. The impressions of the leaves on the shale is, in some specimens, so perfect, that even the venation can be seen; and this is parallel, as is shown in the magnified portion on Plate V., Fig. 6.

The sporangia are considerably smaller than those of *F. gracilis*, as may be seen by a comparison of figure 4, Plate V., with figures 4, 5, 6 of Plate XII. GEOL. MAG. Vol. II., 1865, these various figures being drawn to the same scale. The tri-radiate ridge on the under surface, by which the sporangia were attached to the supporting shale, is more delicate, and is produced further towards the circumference than in the British species. The contents of one of the sporangia in a compacted condition, yet with indications of their original granular state, is shown in Fig. 2. The mineral condition of the sporangia is like that of the specimens I have examined from our British deposits, and which Prof. Morris has described as "neither bituminized nor mineralized, but in a state of brown vegetable matter."

The discovery by Brongniart of a cone containing microspores in the sporangia of its upper portion, and macrospores in those of its lower portion,[1] has led me to re-examine the nature of the contents of the sporangia of these fossils, and somewhat to alter the opinions I expressed in the paper on *Flemingites*, which has been referred to.

While the size of the individual plant is very variable among species of the same natural order of Cryptogamia, that of the organs of reproduction, the spores, is remarkably uniform. The spore of

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Glasgow, to whom science is indebted for the discovery of this very interesting deposit of coal plants. I may add to the synonymy of Corda's species, *Cycadium cyprinopholis*, Guillard = *Cycadites cyprinopholis*, Morris, a fossil from the Coal-measures of the centre of France, hitherto considered to be a Cycadean stem.

[1] Comptes Rendus des Séances de l'Académie des Sciences, Août 17, 1868. Translated in the Journal of Botany, Jan. 1869.

the humble Wall-rue (*Asplenium Ruta-muraria*, L.) is as large as those of the giant Alsophilas and Cyatheas of tropical regions. And this holds good also in respect of allied plants widely removed in time, as, for instance, in the spores of *Equisetum* and *Calamites* (*Volkmannia*). The spore of *Equisetum sylvaticum*, L. measures ·0019 of an inch across, while that of *Volkmannia Binneyi*, Carr. measures ·002 of an inch.

We find also a corresponding relationship between the spores of the palæozoic and those of the living *Lycopodiaceæ*. The microspores of *Selaginella selaginoides*, Link (*Lycopodium selaginoides*, Linn.) are ·0024 of an inch across, while those of Mr. Brown's specimen of *Triplorposites* are ·0022 of an inch in diameter. On the other hand the macrospores of the same *Selaginella* are ·0275 of an inch in diameter, while the macrospores discovered and described by Brongniart in his specimen of *Triplosporites* are, he says, ten or twelve times the size of the microspores, that is to say, taking the measurement from Mr. Brown's specimen, from ·022 to ·0264 of an inch. The singular relationships indicated by these actual measurements between the spores of the *Lycopodiacæ* are very remarkable. They moreover establish beyond question that the spores of *Lepidostrobus*, and those described by Robert Brown in his specimen of *Triplosporites*, are microspores.

The contents of the sporangia of *Flemingites* have been so altered before fossilization that the individual spores cannot be separated. In *F. gracilis* I found several specimens which presented slight prominences produced by grains in the interior. These prominences have a diameter of .0028 of an inch, which, making an allowance for increase of size produced by the interposed wall of the sporangium agrees exactly with the measurement of the microspores of *Triplosporites*. The contents of some of the sporangia of *F. Pedroanus* present also a granulated appearance, a slight remaining indication of the original individual spores, and these agree in size with the prominences on the sporangia of *F. gracilis*.

It follows, then, from these considerations, that these arborescent genera are true *Lycopodiaceæ*, completely agreeing in the structure, economy, and size of their spores with the living, though very diminutive, members of the Order; and further that, as among the living representatives, some genera (*Selaginella* and *Isoetes*) have both macrospores and microspores, and one large genus (*Lycopodium*) has, as far as known, only microspores, so, in the palaeozoic forms, *Lepidostrobus* and *Flemingites* have microspores only, while in *Triplosporites* both forms exist.

Mr. Binney lately communicated to the Literary and Philosophical Society of Manchester a paper on *Lepidostrobus* and allied cones, the abstract only of which has been published. In this abstract it is said, "In the new genus *Flemingites*, described and figured by Mr. Carruthers in Vol. II. of the GEOL. MAG. for October, 1865, there are two kinds of sporangia, those in the upper part of the long and slender cone being something like the sporangia of the *Lepidodendron*, but arranged in whorls, and probably filled with microspores, whilst the lowest scales supported sporangia, containing macrospores. This the author gathered from much more perfect specimens than those which Mr. Carruthers had to work upon. Most certainly the little flattened discs which he described as sporangia are found on scales at the base of the cone, and not in the middle or upper portions of it, as many of the author's specimens clearly proved."

Being unable to understand precisely the structure of the cones in Mr. Binney's collection from this abstract (made obviously by some one ignorant of the subject with which the author was dealing), and being engaged in working out the points treated of in this paper, I asked Mr. Binney for some additional information, but he informed me that he was about to publish a full account with illustrations, and therefore wished to reserve his more detailed description till then. As, however, the statements published in this quotation are in opposition to the views I formerly published, and have more fully explained above, it is necessary that I say a word or two on the more important points contained in it.

There can be no doubt, as there stated, that the little discs were borne on the scales of the lower half of the cone of *Flemingites*, seeing that the original specimen was the lower half of a cone; but it is also equally certain that these little discs were borne as well on the scales of the middle and upper portions, for the British Museum has recently acquired a complete specimen, in which they are to be found on all the scales from the top to the bottom. The specimen to which I have already alluded as figured by Lindley and Hutton under the name of *Lepidostrobus variabilis*, shows also this structure. Besides these I have seen two specimens from Burdie House which, though not so well preserved, are equally decisive as to this point. So that whatever is the nature of Mr. Binney's cone with Lepidostrobus-like sporangia on the upper half, it has nothing whatever to do with *Flemingites.*

It is also certain, if the points I have stated in this paper are of any value, that the sporangia on the lower half of the cone do not contain macrospores.

But the cone described in this abstract cannot belong to any of these palæozoic *Lycopodiaceæ*, as it would be an anomaly in the vegetable kingdom, and would contradict the ascertained laws of vegetable morphology, if a plant which had its true leaves arranged in spirals, had its modified leaves, forming the fruiting cone, arranged in whorls. The words of the abstract imply a still less possible structure, for it gives Mr. Binney the credit of believing the leaves of the lower portion of the cone to be arranged in spirals, as described and figured by me, while in the upper portion they are arranged in whorls, but this must be one of those errors which the person making the abstract has unwittingly made.

Næggerathia obovata, sp. nov. Frond sessile flat, entire, elongate-obovate, attenuated towards the base; nerves dividing dichotomously, parallel. (Plate VI. Fig. 1.)

Odontopteris Plantiana, sp. nov. Pinnules broad at the base, irregularly lobed, obtuse at the apex, basal pinnules large, much and irregularly lobed; nerves arcuately parallel, dichotomous. (Pl. V. Figs. 2 & 3.)

I have associated the name of Mr. Plant with this species, as it is to his intelligent investigation of these deposits that I am indebted for the interesting specimens I have described.

EXPLANATION OF PLATES V. AND VI.

PLATE V.

Flemingites Pedroanus.

Fig. 1. Fragment of a stem showing the permanent bases of the petioles attached, and imbricating.
Fig. 2. Sporangium laid open showing the granulated contents.—Greatly magnified.
Fig. 3. Upper surface of a sporangium.—Greatly magnified.
Fig. 4. Sporangium, magnified to the same scale as those of *F. gracilis*.—Geol. Mag., Vol. II., Plate XII.
Fig. 5. Sporangium with part of the upper surface removed, and showing the depression in the interior produced by the inferior tri-radial ridge.—Greatly magnified.
Fig. 6. Fragment of leaf shewing the parallel venation.
Fig. 7. Termination of a branch showing the solid axis, permanent bases of the petioles, and leaves.
Fig. 8. Fragment of a branch.
Fig. 9. " "
Fig. 10. " "
Fig. 11. A few scars from Fig. 10 magnified four times.

PLATE VI.

Fig. 1. *Næggerathia obovata* (natural size).
Fig. 2. Portion of a pinna of *Odontopteris Plantiana*.
Fig. 3. Lower pinnule of the same (both natural size).

IV.—On the Measurement of River-sediment.

By the Rev. J. D. La Touche.

ALLOW me to call the attention of your readers to an investigation which promises to be of considerable geological importance, and which might be pursued in many places without any difficulty —I mean the determination of the quantity of sediment carried down to the sea by rivers.

Obviously, if this could be ascertained, we should have some measure of the rate of denudation of the surface of the country, and that vagueness which attends most calculations relating to geological epochs would, in some degree, be removed.

For this purpose it will be, perhaps, best to detail some experiments which I have myself been making with this view, upon the River Onny which flows by my house.

1st. A tolerably straight and uniform reach of the river was chosen, and along the bank 100 feet were measured and marked by pegs driven into the ground. Here a marked post was erected in the water, to take the height of the flood from time to time. This is done every day after any considerable fall of rain, and at the same time the rate at which the centre of the stream moves is ascertained, by counting with a watch the number of seconds any floating substance takes to pass the measured 100 feet.

2nd. An accurate section of the river is made by sounding. From these data the number of cubic feet of water which pass this point in a given time can be calculated, by knowing the ratio of the speed of the centre, to the mean velocity of the whole stream. I am informed by an able practical engineer, who has had much experience in this matter, that this is represented by the fraction fourfifths. But it seems to me that this rule can hardly be very accurate, and that it would be desirable to find the mean velocity by the use of a current metre, working in different parts of the section. However, this element once determined, it is of course only necessary to multiply the area of the section in feet, by the mean velocity in feet for a given time, to ascertain the number of cubic feet which flow past in that time.

3rd. The proportion of sediment held in suspension is ascertained by collecting a certain measure of water (a quart bottle answers the purpose very well), and then decanting and filtering it. If the filter be carefully dried and weighed, before and after the experiment, the difference gives the weight of mud from which the per centage of grains to ounces of water can be obtained. We shall now have sufficient data to determine how much solid matter passes down the river in a given time at any flood.

4th. Besides these observations, the rainfall at different points of the watershed of the river should be carefully registered. Thus some correlation between the two could probably be ascertained, so that from year to year an average rate of the wear and tear of the surface of the land might be obtained.

Many subjects of interest will naturally suggest themselves as we proceed with these experiments, such as the variation of the sediment after a long drought, and after a continued fall of rain.

Of the above data, the most unsatisfactory are those relating to the mean velocity of the stream at different heights. Perhaps some of your readers may be able to furnish suggestions upon the best mode of ascertaining this.

Besides the mud actually held in suspension, it would be very desirable to determine the rate at which the mud, sand, and gravel which compose the bed of the river are propelled. Some suggestions on the means of doing so would be very acceptable.

STOKESAY, CRAVEN ARMS, SALOP,
February 5th, 1869.

V.—ON THE INFLUENCE OF THE GULF-STREAM.

By JAMES CROLL, of the Geological Survey of Scotland.

THE modern method of determining the amount of heat effects in absolute measure is no doubt destined to cast new light on all questions connected with climate, as it has done and is still doing in every department of physics where energy under the form of heat is the phenomenon under consideration.

Owing to the complicated nature of the phenomena with which the meteorologist has generally to deal, the application of this method will very often be found practically impossible. The method, however, is particularly suitable to all questions regarding the direct thermal effects of currents, whatever the nature of those currents may happen to be.

If the question, for example, is asked—"Is the heat conveyed by the Gulf-stream sufficient to affect to any great extent the climate of Northern Europe and the Arctic regions?" the answer can be given in the most positive manner by determining the absolute quantity of energy in the form of heat conveyed by the stream.

The fact of the climate of our island being greatly modified by the heat derived from the Gulf-stream has lately been called in question by Mr. A. G. Findlay and some others.

Mr. Findlay takes the breadth of the stream, as it issues from the Gulf of Mexico, at 45 miles, and its depth at 900 or 1200 feet, and maintains that a stream of this size, leaving the Gulf with a velocity of only a few miles an hour, would not be able to force itself across the Atlantic and onwards to the Polar Regions against the Arctic current and other impediments in its way; and even supposing it were able to do this, still its volume, he asserts, is too small and its temperature too low to produce the thermal effects attributed to it. It is certainly, no doubt, true that if the Arctic current was an *opposing* current as well as a contrary one, and if the Gulf-stream had to push its way to the Polar Regions by means of some impulse received before leaving the Gulf, it is not at all likely that it would ever reach to even the latitude of New York, far less to the shores of Great Britain. But neither the Gulf-stream nor any other ocean current moves in this manner. It is, however, not with this phase of the objection that I am at present concerned, but with the other and more important one, viz. that a current 45 miles broad and 900 or 1200 feet deep is too small to convey the amount of heat necessary to produce the warming effects usually attributed to the Gulf-stream.

There are perhaps few, if any, who have not actually subjected the matter to calculation, but would be inclined to agree with Mr. Findlay, that a stream so comparatively small, leaving the Gulf of Mexico at a temperature of not over 70° or 80°, and losing heat during a journey of several months across the Atlantic, could not possibly be able to maintain the winter temperature of the whole of Northern Europe 20° or more above the normal. They would naturally conclude that the only way of meeting Mr. Findlay's objection would be by denying that the stream is so small as he asserts it to be.

Although I am inclined to believe that Mr. Findlay has underestimated the volume of the Gulf-stream, still I can see no necessity for insisting on this in order to be able completely to meet his objection; for, taking his estimate of its size, it can be proved that his conclusion is incorrect, as the following, it is hoped, will show.

In the following calculations the breadth of the stream is taken at 50 miles, and its depth at 1000 feet, and its velocity at four miles an hour. This is almost exactly Mr. Findlay's estimate. The temperature of the water on leaving the Gulf is taken as low as 65°.

"The enormous effect that ocean-currents have in equalising the temperature of our globe by diminishing the difference between the temperature of the equator and the poles, has never been duly estimated. This will be seen if we merely consider for a moment the effect produced by one current alone, viz., the Gulf-stream. The *total* quantity of water conveyed by this stream is probably equal to that of a stream 50 miles broad and 1000 feet deep, flowing at the rate of four miles an hour. And the mean temperature of the entire mass of moving waters is not under 65° at the moment of leaving the Gulf."[1] I think we are warranted to conclude that the Gulf-stream, before it returns from its northern journey, is on an average cooled down to at least 40°, consequently it loses 25° of heat. Each cubic foot of water, therefore, in this case carries from the tropics for distribution upwards of 1500 units of heats, or 1,158,000 foot-pounds. According to the above estimate of the size and velocity of the stream 5,575,680,000,000 cubic feet of water are conveyed from the Gulf per hour, or 133,816,320,000,000 cubic feet daily.[2] Consequently the total quantity of heat transferred from the equatorial regions per day by the stream amounts to 154,959,300,000,000,000,000 foot-pounds. From observations made by Sir John Herschel and by M. Pouillet on the direct heat of the sun, it is found that were no heat absorbed by the atmosphere, about 83 foot-pounds per second would fall upon a square foot of surface placed at right angles to the sun's rays.[3] Mr. Meech estimates that the quantity of heat cut off by the atmosphere is equal to about 22 per cent. of the total amount received from the sun. M. Pouillet estimates the loss at 24 per cent. Taking the former estimate, 64·74 foot-pounds per second will therefore be the quantity of heat falling on a square foot of the earth's surface when the sun is in the zenith. And were the sun to remain stationary in the zenith for twelve hours, 2,796,768 foot-pounds would fall upon the surface.

It can be shown that the total amount of heat received upon a unit-surface on the equator during the twelve hours from sunrise till sunset at the time of the equinoxes is to the total amount which would be received upon that surface, were the sun to remain in the zenith during those twelve hours, as the diameter of a circle to half its circumference, or as 1 to 1·5708. It follows, therefore, that a square foot of surface on the equator receives from the sun at the time of the equinoxes 1,780,474 foot-pounds daily, and a square mile 49,636,750,000,000 foot-pounds daily. But this amounts to only $\frac{1}{3,121,870}$ part of the quantity of heat daily conveyed from the tropics by the Gulf-stream. In other words, the Gulf-stream conveys as much heat as is received from the sun by 3,121,870 square miles of surface at the equator. The amount thus conveyed is equal to all the heat which falls within 63 miles on each side of the equator. According to calculations made by Mr. Meech,[4] the annual quantity of heat received by a unit surface on the frigid zone, taking the mean of the whole zone, is $\frac{5\cdot45}{12}$ of that received at the equator. Consequently the quantity of heat conveyed by the Gulf-stream in one year is equal to the heat which falls on an average on 6,873,800 square miles of the arctic regions. The frigid zone or arctic regions contain 8,130,000 square miles. There is actually, therefore, nearly as much heat transferred from the tropical regions by the Gulf-stream as is received from the sun by the entire arctic regions; the quantity conveyed by the stream to that received from the sun by those regions being as 15 to 18.

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[1] Phil. Mag. for February 1867, p. 127.

[2] Captain Maury considers the Gulf-stream equal to a stream 32 miles broad and 1200 feet deep, flowing at the rate of five knots (38,415 feet) an hour (Physical Geography of the Sea, § 24). This gives 6,166,700,000,000 cubic feet per hour as the quantity of water conveyed by this stream. Sir John's Herschel's estimate is still greater. He considers it equal to a stream 30 miles broad and 2200 feet deep, flowing at the rate of four miles an hour (Physical Geography, § 54). This makes the quantity 7,359,900,000,000 cubic feet per hour. Sir John estimates the temperature at 86° F.

[3] Trans. of Royal Soc. of Edin., Vol. xxi., p. 57. Phil. Mag. S. 4, Vol. ix. p. 36.

[4] Smithsonian Contributions to Knowledge, Vol. IX.

But we have been assuming in our calculations that the percentage of heat absorbed by the atmosphere is no greater in polar regions than it is at the equator, which is not the case. If we make due allowance for the extra amount absorbed in polar regions in consequence of the obliqueness of the sun's rays, the total quantity of heat conveyed by the Gulf-stream will probably nearly equal the amount received from the sun by the entire arctic regions.

If we compare the quantity of heat conveyed by the Gulf-stream with that conveyed by means of aërial currents, the result is equally startling. The density of air to that of water is as 1 to 770, and its specific heat to that of water is as 1 to 4·2. Consequently the same amount of heat that would raise 1 cubic foot of water 1° would raise 770 cubic feet of air 4°·2, or 3234 cubic feet 1°. The quantity of heat conveyed by the Gulf-stream is therefore equal to that which would be conveyed by a current of air 3234 times the volume of the Gulf-stream, and at the same temperature and moving with the same velocity. Taking, as before, the width of the stream at 50 miles, and its depth at 1000 feet, and its velocity at 4 miles an hour, it follows that in order to convey an equal amount of heat from the tropics by means of an aërial current, it would be necessary to have a current about 1¼ mile deep and at the temperature of 65° blowing at the rate of four miles an hour from every part of the equator over the northern hemisphere towards the pole. If its velocity were equal to that of a good sailing-breeze, which Sir John Herschel states to be about twenty-one miles an hour, the current would require to be above 1200 feet deep. A greater quantity of heat is probably conveyed by the Gulf-stream alone from the tropical to the temperate and arctic regions than by all the aërial currents which flow from the equator.

We are apt, on the other hand, to over-estimate the amount of heat conveyed from tropical regions to us by means of aërial currents. The only currents which flow from the equatorial regions are the upper currents or anti-trades, as they are called. But it is not possible that much heat can be conveyed to us directly by them. The upper currents of the trade-winds, even at the equator, are nowhere below the snow-line. They must, therefore, lie in a region actually below the freezing-point. In fact, if those currents were warm, they would elevate the snow-line above themselves. The heated air rising off the hot burning ground at the equator, after ascending for a few miles, becomes exposed to the intense cold of the upper regions of the atmosphere. It then very soon loses all its heat, and returns from the equator much colder than it came. It is impossible that we can receive any heat directly from the equatorial regions by means of aërial currents. It is perfectly true that the south-west wind, to which we owe so much of our warmth in this country, is a continuation of the anti-trade. But the heat which this wind brings to us is not derived from the equatorial regions. This will appear evident, if we but reflect that, before the upper current descends to the snow-line after leaving the equator, it must traverse a space of at least 2000 miles; and to perform this long journey several days will be required. During all this time the air is in a region below the freezing-point; and it is perfectly obvious that by the time it begins to descend it must have acquired the temperature of the region in which it has been travelling.

If such be the case, it is evident that a wind whose temperature is below 32° could never warm a country such as ours, whose temperature does not fall below 38° or 39°. The heat of our south-west winds is derived, not from the equator but from the warm water of the Atlantic—in fact, from the Gulf-stream. The upper current derives its heat after it descends to the earth. There is one way, however, whereby heat is indirectly conveyed from the equator by that current; that is, in the form of aqueous vapour. In the formation of one pound of water from aqueous vapour, as Professor Tyndall strikingly remarks, a quantity of heat is given out sufficient to melt five pounds of cast iron.[1] It must, however, be borne in mind that the greater part of the moisture of the south-west and west winds is derived from the ocean in temperate regions. The upper current receives the greater part of its moisture after it descends to the earth. The greater part of the moisture received at the equator is condensed and falls as rain in those regions.

These, as well as many other considerations which might be stated, lead to the conclusion that, in order to raise the mean temperature of the whole earth, water should be placed along the equator—and not land, as is generally believed. For if land is placed at the equator, we prevent the possibility of conveying the sun's heat from the equatorial regions by means of ocean-currents. The transference of heat could only then be effected by means of the upper currents of the trades; for the heat conveyed by *conduction* along the solid crust, if any, can have no sensible effect on climate. But these currents, as we have just seen, are ill adapted for conveying heat.

The surface of the ground at the equator becomes intensely heated by the sun's rays. This causes it to radiate off its heat more rapidly into space than a surface of water heated under the same conditions. Again, the air in contact with the hot ground becomes also more rapidly heated than in contact with water; and consequently the ascending current of air carries off a greater amount of heat. But if the heat thus carried away were transferred by means of the upper currents to high latitudes and there employed to warm the earth, then the heat thus conveyed might to a considerable extent compensate for the absence of ocean-currents, and land at the equator might in this case be nearly as well adapted as water for raising the temperature of the whole earth. But such is not the case; for the heat carried up by the ascending current at the equator is not employed in warming the earth, but is thrown off into cold stellar space above. This ascending current, instead of being employed in warming the globe, is in reality one of the most effectual means that the earth has of getting quit of the heat received from the sun, and of thus retaining itself at a much lower temperature than it would otherwise be. It is in the equatorial regions that the earth loses as well as gains the greater part of its heat. So of all places it is here that we ought to place the substance best adapted for preventing the dissipation of the earth's heat into space if we wish to raise the general temperature of the earth. Water, of all substances in nature, seems to possess this quality to the greatest extent; and, besides, it is a fluid, and therefore adapted by means of currents to carry the heat which it receives from the sun to every corner of the globe."[1]

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[1] Heat as a Mode of Motion, article 240.

VI.—NOTES ON CONTINENTAL GEOLOGY AND PALÆONTOLOGY.

By THOMAS DAVIDSON, F.R.S., F.G.S.

(PART I.)

RECENT considerations of health having induced me to spend from five to six months on the continent, I beg to submit to the readers of the GEOLOGICAL MAGAZINE the result of my notes made during my journey, which may perhaps prove not entirely uninteresting.

I. *On the Cretaceous System.*—All the foreign geologists with whom I have had occasion to converse in France, Switzerland, and Italy, concur in the opinion that no country has been better studied than Great Britain, and that the Museum of the Geological Survey and its published Maps are unsurpassed by any works of a similar kind hitherto produced.[2]

Our geologists have done their work well, and justly deserve the favourable judgment so liberally bestowed upon them by their continental colleagues; but we must not therefore suppose that our geological work is perfected and that we have no more to learn—for example—that our classification of British strata is either complete or entirely satisfactory. It is absolutely necessary we should know and compare the labours of continental observers with our own and see whether their discoveries or hints might not lead us to improve or correct our system: *at the same time carefully avoiding the introduction of any foreign terminology on English ground until such may have become a well-recognized and absolute necessity.*

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[1] Trans. of Glasgow Geol. Soc. vol. ii. part iii. p. 185; Phil. Mag. Feb. and June, 1867.

[2] See "De la Science en France" by Jules Marcou, 1869. This work, to which I would call the attention of British geologists, is being published in numbers, and treats of the Imperial School of Mines, the Geological Map of France, the Academy and Institute of France, and of the Museum of Natural History in Paris, and may be obtained from C. Reinwald, Bookseller, 15, Rue des Saint Pères, Paris; or through Messrs. Trübner & Co.

With reference to the Cretaceous system and its divisons there still remains in England ground for improvement, but I must at the same time remind the English reader that the French, Swiss, and German geologists are far from unanimous in their terminology, or as to the number or value of all their divisions. Very earnest discussions are now in active progress between those who in France are best qualified to express an opinion upon this difficult and important topic.

I will not enter here upon the general literature of the subject, my object being simply to draw attention to the most recent views entertained by continental geologists. It may however be desirable for the better understanding of what will follow to mention at once that the Cretaceous system in England has been divided in the following manner:

1. Upper Chalk
2. Lower Chalk
3. Chalk Marl
4. Chloritic Marl
5. Upper Green Sand
6. Gault
7. Lower Green Sand
8. Neocomien
9. Wealden

and that it is mainly due to Mr. Judd's admirable labours on the Speeton Clay, that the existence of a large portion of the Neocomien formation in England has been recently established. Mr. Judd is prepared to stand by the succession of beds which he described at Speeton,[1] admitting at the same time that their grouping is to a great extent arbitrary, as there are no stratigraphical breaks, and that he was guided by all he then knew of the character of the French and Jura Neocomien especially, from d'Archiac and the Swiss geologists. Mr. Judd would, however, be prepared to modify his classification so soon as sufficient cause may be shown. I am happy to be able to state also that foreign geologists have warmly acknowledged the great value of Mr. Judd's researches and inductions.—The valuable labours of Mr. C. J. A. Meÿer, Prof. Morris, the Rev. T. Wiltshire, Mr. J. F. Walker, and of some others,[2] have also materially contributed within the last few years towards clearing away some of those difficulties which still beset the final settlement of our divisions.

In France the old nomenclature was rejected by M. Alcide d'Orbigny, who divided the system into the following stages:

1. Danien
2. Sénonien
3. Turonien
4. Cénomanien
5. Albien
6. Aptien
7. Urgonien
8. Neocomien.

For many years M. Coquand, a very able and experienced geologist, has been devoting considerable attention to the Cretaceous systems generally, and especially to those divisions so largely developed in the South of France, and during my passage through Marseilles he kindly wrote out the following table, in which his views are correctly defined.

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[1] Quart. Journ. Geol. Soc. for August, 1868.

[2] These papers will be found in the volumes of the GEOLOGICAL MAGAZINE, the Proceedings of the Geologists' Association, and the Quarterly Journal of the Geological Society.

I. Upper Chalk.

1. **Garumnien** (Leymerie), named after the department of the Garonne—

Sphærulites Leymerii (Bayle), *Cyrena garumnica*, *Lychnus Matheroni*. It is of fresh-water origin in Provence, and fluvio-marine in the Pyrenees. It comprises the Pisolitic stage of d'Orbigny. Mr. Leymerie places it on a parallel with the étage Danien, but I believe this to be a mistake. It does not exist in England.

2. **Dordonien** (Coquand), after the department of Dordogne—

Sphærulites ingens, *Hippurites radiosus*, *Radiolites Jouanneti*, *Ostrea Villei*, etc. It includes the upper beds of Maestricht which contain the same Rudists as in the Dordogne. It also comprises the Sénonien of d'Orbigny (upper portion), and is wanting in England.

3. **Campanien** (Coquand), from the country of Champaign or Cognno—

Ostrea vesicularis, *Belemnitella mucronata*, *Terebratula carnea*, *Ananchytes ovatus*, *Hemipneustes radiatus*, *Baculites Faujasi*, *Radiolites Hœninghausi*. It corresponds to the Sénonien of d'Orbigny: to the Danien of the same author, who, by mistake, identifies it with the Pisolitique: it is the White Chalk of the English, the Craie blanche de Meudon of the French; the Obere Kreide of the German Geologists.

4. **Santonien** (Coquand), from Saintonge—

Micraster cor-anguinum, *Belemnitella quadrata*, *Spondylus truncatus*, *Rhynchonella vespertilio*, *Ostrea semi-plana*, *O. frons Radiolites fissicostatus*. It corresponds to the Sénonien of d'Orbigny: to the upper portion only of the Lower Chalk, to the Craie Marneuse, and Craie de Velledieu; to the Oberer Planer of the Germans.

5. **Coniacien** (Coquand), from Cognac—

Rhynchonella Baugasi, *Sphærulites Coquandi*. It corresponds to the base or lower portion of the Sénonien of d'Orbigny: to the Sables d'Aix-la-Chapelle (base), and is not found in England.

II. Middle Chalk.

1. **Provencien** (Coquand) after the Provence—

Hippurites cornu-vaccinum, *H. organisans*, *Sphærulites Sauvagesi*, *S. angeiodes*, *Caprina Coquandi*. It corresponds to the Turonien of d'Orbigny.

2. **Mornasien** (Coquand), after Mornas Vaucluse—

Ammonites Requieni, *Arca Matheroni*. It comprises the celebrated Grès d'Uchaux (Turonien of d'Orbigny), and is wanting in England.

3. **Angoumien** (Coquand), after Angouleme—

Radiolites cornu-pastoris, *R. lumbricalis*, *Hippurites Requieni*. Is wanting in England, but corresponds to the Turonien of d'Orbigny.

4. **Ligerien** (Coquand), after the Loire—

Inoceramus problematicus, *Ammonites Fleurianus*, *A. papalis*, *Terebratella Carentonensis*. It corresponds to the lower portion of the Lower Chalk of England, to the base of the Craie Marneuse: to the Craie Tuffeau, to the Turonien of d'Orbigny: Mittler Quadermergel, Plänerkalk of the Germans.

5. **Carentonien** (Coquand), after the department of the Charente—

Caprina adversa, *Sphærulites foliaceus*, *Ostrea biauriculata*, *O. columba*, *O. flabellata*, *Terabratula phascolina*. It corresponds to the Cénomanien of d'Orbigny: to the Sables du Mans, Chalk Marl of English geologists, Unterer Pläner of the Germans.

6. GARDONIEN (Coquand), after the Gard—

Vicarya Renauxiana, Teredo Fleuriausi. This stage is of lacustrine origin, and will require hereafter to be united either to No. 5 or 7.

7. ROTHOMAGIEN (Coquand), after Rouen—

Ammonites Rothomagensis, A. varians, A. falcatus, Scaphites æqualis, Turrilites costatus, Pecten asper, Terebratella pectita, T. lyra, Ostrea conica, Radiolites Mortoni. It corresponds to the Craie Chloritée or Glauconieuse, to the Upper Green Sand (Warminster Sand), the Cénomanien of d'Orbigny; Unterer Planer inferieur (Greensand of Essen).

8. VRACONIEN (Renevier), from Vraconne in Switzerland—

Ammonites inflatus, Rhynchonella sulcata, Am. auritus, A. latidorsatus. It corresponds to the Gault Superieur of the Swiss, to the Cambridge Upper Gault or Green Sand, Flammenmergel of the Germans.

ALBIEN (d'Orbigny)—

Ammonites splendens, A. mamillaris, A. Raulini. It corresponds to the real Gault of Folkstone and Wissant, to the Oberer and Mittler Gault of the Germans.

III. LOWER CHALK.

1. URGO-APTIEN—

1. Argiles à Plicatules—*Ammonites nisus, A. Gargasensis; Plicatula placunea, Belemnites semicanaliculatus, Ostrea æquila, Terebratella Astieriana* (Lower Green Sand of the English geologists), Aptien of d'Orbigny, Unterer Gault, Mergel, and U. G. Thon of the Germans.
2. Couches à Orbitolites—*Ancyloceras Matheronianum, Plicatula placunea, Belemnites semicanaliculatus, Ammonites fissicostatus, Nautilus plicatus, Heteraster oblongus, Pseudodiadema Malbosi, Caprotina Lonsdalii, Ostrea aquila, O. macroptera, Orbitolites lenticularis.* (Etage Rhodanien of Renevier).
3. *a.* URGONIEN (d'Orbigny) *Requienia Lonsdali, R. ammonia, Nerinea Coquandi, N. Archimedi, N. gigantea, Heteraster oblongus, Ostrea aquila. Nautilus plicatus, Orbitolites lenticulata, Scaphites Tranii.*
   b. BARREMIEN (Coquand) *Ancyloceras Duvalii, A. Emerici, A. Tabarelli, Terebratella Astieriana, Ostrea Leymerii.*

   a. and *b.* are parallel, *a.* represents the coral aspect, *b.* the littoral aspect, both correspond to the Argiles Ostréennes. As we find them in Provence so is it in the Pyrenees and Spain; there exist alternations between the Aptien beds and the Urgonien, and it became consequently necessary to form of the two a single division. The subdivisions denote a peculiar facies, a petrographical character, which nevertheless varies according to the country where observed. These three subdivisions correspond with the Upper and Middle Neocomien of Mr. Judd, to the Neocomien Superieur of M. Cornuel.

2. NEOCOMIEN—

Ammonites Astierianus, A. multiplicatus, Ostrea Couloni, O. rectangularis, Toxaster complanatus, Belemnites latus, and *dilalatus.* It corresponds to the Marnes d'Hauterive, Lower Neocomien of Judd; Hills, of the Germans.

3. VALENGIEN—

Ammonites Gervilianus, Strombus Sautieri, Pygurus rostratus. The equivalent of the Wealden of England, and of the first stage of the Neocomien inferieur of Cornuel.

From the above it would appear that M. Coquand divides the Cretaceous system into seventeen étages or divisions, of which nine only would seem to occur in Great Britain.

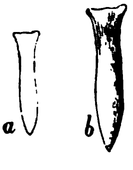
To our White Chalk he applies the term *Campanien,* while to the *upper portion* only of our Lower Chalk the term *Santonien* is given, then according to the same geologist, four divisions would intervene, in France, between the *upper portion* and the *lower one* of our Lower Chalk, to which last the term *Ligérien* is applied. This is followed (always in the descending order) by Coquand's étage *Carentonien*, which comprises our Chalk Marl. Here again another break would seemingly occur in the shape of his étage *Gardonien*, prior to reaching our Upper Green Sand, his *Rothomagien*. Under this last comes the étage *Vraconien* or Cambridge beds, which I found was well developed in the neighbourhood of Nice, and to which we will hereafter refer, while treating of the geology of the department of maritimes Alps. Immediately under the Vraconien we find the true Gault, (of Folkstone and Wissant) or étage Albien of French geologists. In the étage *Urgo-Aptien*, he places the Lower Green Sand, the Aptien and a portion of the Neocomien of Judd, while the true *Neocomien* would comprise the Lower Neocomien of the last named author. That gentleman informs me that the reference of the Speeton Clay to the *Aptien*, made by so many geologists on the Continent, is due to the fact that, with two or three exceptions, all the specimens figured by Phillips in the "Geology of Yorkshire," are from the cement beds, which he regards as certainly of Aptien age.

(To be continued).

VII.—On the Oldest British Belemnite.

By Raplh Tate, Assoc. Lin. Soc., F.G.S., etc.

PROFESSOR PHILLIPS remarks that "from the Inferior Oolite downwards through the Liassic series Belemnites are almost never absent from the section till we reach the zone of *Ammonites Bucklandi*; only in the upper part of this zone have they been found—at Salford and at Lyme Regis," But as the unique example—the subject of the present communication—was collected from the zone of *Ammonites angulatus*, it is the oldest known British Belemnite, and as such claims some attention.



a. Outline of *B. præmaturus*, nat. size.
b. Enlarged.

The only notice that I am acquainted with of the occurrence of Liassic Belemnites in strata older than the Bucklandi beds is that by Jules Martin, who records *Bel. acutus*, Miller, in his zone of *Ammonites Moreanus*, which is the equivalent in the Cote d'Or of the zone, of *Ammonites angulatus*.

Description of the Species.—Belemnites præmaturus, mihi. Guard, slightly subhastate, (terminating in an acute central point,) ? contracted in all the regions about the alveolar apex, and tapering very gradually to the point. On the lateral faces of the anterior part of the guard there are two distinct lateral furrows which extend to about the middle part. Axis apparently straight. *Phragmocone* in its transverse section sub-oblong, the dorso-ventral diameter being the longer. Extreme length ·35 inch; length of axis, so far as traceable, ·11 inch.

Locality and Formation.—In the zone of *Ammonites angulatus*, Lower Lias; Island Magee, Co. Antrim.

Remarks.—The only Belemnites in the Lower Lias of Ireland are *B. acutus*, Miller, and *B. pencillatus*, Sow., which occur in strata newer than the zone of *Ammonites Bucklandi*, which intervenes between these Belemnite beds and the zone of *Ammonites angulatus*, whence *B. prœmaturus* was obtained. Naturally the question arises, may not this form be the young state of one or other of these species, but the presence of lateral furrows in *B. prœmaturus* precludes such a relation. The affinity to *B. clavatus* is more obvious, but it has not the elegant fusiform outline of the young of that species; however, the smallest specimen of *B. clavatus*, Bl., with which I have compared *B. prœmaturus*, is not less than one inch in length; my species has more of the form of *B. dorsalis*, Phillips.

The uncertain value of specific determinations based on immature specimens must apply in great force to the species I have described; yet on the other hand insignificant characters observable in the young assume magnified importance in adult individuals, and from such considerations I regard *B. prœmaturus* as distinct from, though closely allied to, *B. clavatus*.

VIII.—ON THE RELATIONS BETWEEN THE SKIDDAW SLATES AND THE GREEN SLATES AND PORPHYRIES OF THE LAKE-DISTRICT.[1]

By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S.

IN the former portion of this paper, the upper or south-eastern boundary of the Skiddaw Slates, in their main area, had been traced from Troutbeck, on the N.E., as far as the head of Buttermere, on the S.W. From this point (*i.e.* the north-western end of Honister Crag), the Skiddaw Slates can be traced for a very short distance across Warnscales Bottom. They are still overlaid by the felspathic trap and succeeding band of slates and breccias, which together compose Fleetwith Pike and the S.E. end of Honister Crag, and the relations between the two formations are the same as in the Gatescarth Valley. When however the pass of Scarf Gap on the south-west of Warnscales is reached, the Skiddaw Slates have disappeared and the base of the Green Slate Series now rests upon a great mass of intrusive felstone-porphyry (here almost a true syenite) which forms High Crag and High Stile. Though the Skiddaw Slates are absent here, it is interesting to observe that the stratification of the Green Slate Series can be particularly well made out in this region. The rugged hills to the S.E. of Scarf Gap are occupied by a prolongation of the great slaty band of Honister, but the beds have now to a great extent lost their former character, and have assumed very much the mineral aspect of trap, from which however they are easily distinguished by the fact that the bedding, in spite of a rough but well marked cleavage, is unusually distinct. The strata are excellently displayed in a number of magnificently *moutonné'd* crags and bosses, in which they are seen to undulate repeatedly, forming a series of small but well-preserved anticlinals and synclinals, the dips of which are N.N.W. and S.S.E. at angles of from 25° to 35°. The inclination therefore of these beds is only about half as high as that of the Skiddaw Slates in the Gatescarth Valley.

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[1] Continued from the March Number, p. 108

From Scarf Gap to a point a little to the south of the foot of Ennerdale Lake—a distance of more than five miles—the Green Slates and Porphyries continue to repose upon the syenitic porphyry before-mentioned, this intrusive mass occupying the lower half of the valley of the Liza, and forming the range of hills which bound Ennerdale on the south. At this point, which is near the source of the river Calder, the Green Slates again come into relation with the Skiddaw Slates and continue to be underlaid by them for about four miles until we come to Stockbridge near Egremont. Along this line however the hills are low and rounded and the country is much obscured by drift so that little can be said as to the relations of the two formations. Wherever seen the inclination of the Skiddaw Slates is found to be at very high angles, varying from S.S.E. at 55°, as at Flat Fell and Dent Hill, to verticality as at Wilton. They are overlaid by traps and trappean breccias belonging to the Green Slate Series, but no dip could be made out in these beds and their junction with the Skiddaw Slates is nowhere observable.

The Skiddaw Slates in their main area in the north-western portion of the Lake district, as is well known, ultimately fold over towards the N.W., and are partially succeeded by a belt of country in which rocks belonging to the series of the Green Slates and Porphyries come to the surface. Between Egremont and Cockermouth, and again between Cockermouth and Sunderland, the Skiddaw Slates are overlapped by the Carboniferous Limestone, and their upward termination is, therefore, not exhibited. A little to the north of Sunderland, however, strata belonging to the Green Slates begin to make their appearance, and continue to be superimposed upon the Skiddaw Slates throughout the remainder of this area, till close upon Troutbeck Station, where the Skiddaw Slates are again concealed for a distance of about a mile, partly by Old Red and partly by the Carboniferous Limestone. Throughout the whole of the distance between Troutbeck and Sunderland—a distance of about fifteen miles—the Green Slates and Porphyries constitute a well-defined, somewhat semi-circular, range of hills, which commences near Sunderland in the Beacon Hill and Binsey Crag, is continued by the mountains round Overwater, runs nearly due E. and W. from this point to a little to the south of Hesket-new-Market, (as the Caldbeck Fells), and then suddenly turns to the S.E. by Bannest Hill and Murrah to Eycott Hill near Troutbeck. In examining this comparatively little known range, we shall find a clearer exposition of the true relations between the Skiddaw Slates and the Green Slates, than is obtainable in any other part of the Lake-district.

Commencing in the neighbourhood of Sunderland, the Skiddaw

Slates are found occupying a broad tract of flat moorland ground, which forms the southern half of Torpenhow Common, and which is cut through by several small streams which constitute the head-waters of Isell Beck, a tributary of the Derwent. The strata which occupy the whole of this region are soft, black, earthy shales, and they constitute the *upper* beds of the Skiddaw Slates. Such sections, however, as there are, are very small, and the exact relations of the strata can with difficulty be made out. That their general dip must be northwards is tolerably certain, since the lower beds of the Skiddaw Slates, as seen in the Embleton Valley and in the ridge of hills which separates this from the valley of the Derwent, invariably have a N.N.W. inclination. And this, on the whole, seems to be the dip of the upper beds, which, though greatly contorted, appear to dip at points between N.E. and N.N.W. at very high angles, as is seen in Scale Gill and Black Beck, and near Bewaldeth Tile-works. The Skiddaw Slates of this moory tract are overlaid on the N.E. by a series of bedded traps, which form the northern half of Torpenhow Common and the whole of Binsey Crag. At one point, near Black Beck, where some slaty beds are seen, the dip of these is N. at 35°. The general strike, however, of these trappean masses is W.N.W. and E.S.E., whereas that of the Skiddaw Slates is E.N.E. and W.S.W., so that a considerable discordance appears here in the strike of the two sets of beds. Between Bewaldeth and Overwater the country is thickly covered with drift, and no sections are obtainable, though there can be little doubt but that this region is still occupied by the upper beds of the Skiddaw Slates.

To the west of Overwater, in a stream called Ellengill Beck, the Skiddaw Slates are very well exhibited. The beds in the ravines at the head of Ellengill, forming the flanks of Great Scaw Fell, are tolerably hard and flaggy, and dip S.S.E. at 40°. In the lower part of Ellengill the strata are very pencilly, and the dip varies from S.S.E. to S. or S.S.W. at angles of from 45° to 60°. These dips continue without alteration, till the Slates are overlaid, about a quarter of a mile above Stockdale, by a fine green trap, which forms the base of the Green Slates. As this trap comes on to the *north* of the Skiddaw Slates, it is evident that in this locality the dip of the Skiddaw Slates is diametrically opposed to that of the Green Slates and Porphyries. From Great Scaw Fell, at the head of Ellengill, the line of junction between the two formations is continued by Great Lingy to the head of Grainsgill Beck (Brandy Gill), the country being very peaty and exhibiting no sections. The southern bank of Grainsgill Beck is composed of metamorphosed gneissic Skiddaw Slates, apparently striking N.E. and S.W., whilst the northern bank of the stream is composed of felspathic trap, which is sometimes highly crystalline, and which forms here the base of the Green Slates. In the lower half of Grainsgill Beck a mass of fine-grained granite comes on, but at the junction of this stream with the Caldew the previous relations are again resumed. Thus the ridge, which here bounds the Caldew on the north and which forms the southern end of Carrock Fell, is composed in its lower part of highly metamorphosed Skiddaw Slate, overlaid in its higher portion by the same felspathic rock before alluded to. The bedding in the Skiddaw Slates is to a great extent obliterated, but it can be sometimes made out, as near Swineside, where the strike is N.E. and S.W., that of the overlying trappean rocks being nearly E. and W. In this district, therefore (from the head of Grainsgill Beck, along the left bank of the Caldew, as far as Mosedale), it will be seen that the base of the Green Slates rests upon the metamorphosed *lower* beds of the Skiddaw Slates, which are so well known as occurring in the higher reaches of the Caldew valley. Not only is this so, but the *strike* of the two formations is entirely at variance.

This last phenomenon, however, is more strikingly exhibited in the remaining portion of this region, namely between Mosedale and Troutbeck. The range of the Caldbeck Fells, as I have said, runs nearly due E. and W., but this ceases to be the case at Mosedale, where it is deflected in a N.W. and S.E. direction, forming a low ridge of craggy hills, which runs from Murrah to Greenah Crag, about three-quarters of a mile to the north of Troutbeck Station. This range, of which Eycott Hill (1131 feet) is the culminating point, is composed of a beautiful series of bedded traps and ashes,[1] constituting the lower portion of the Green Slate series. In a little stream, which flows from the south-eastern extremity of Eycott Hill, this series is excellently exhibited, and their inclination can be most satisfactorily determined, by means of an ash-bed included between two sheets of trap, to be N.E. at 30°. They strike, therefore, N.W. and S.E. Though the country immediately to the S.W. of Eycott Hill is much obscured by drift,[2] and is without any rock-exposure, there can be no doubt but that it is occupied by the Skiddaw Slates. Thus, in the course of Gills Beck, to the east of Troutbeck Station, the upper shaly beds of the Skiddaw Slates are seen, striking E.N.E. and W.S.W., and dipping N.N.W. at angles of from 50° to 60°. The S.W., extremity of Eycott Hill must, therefore, rest upon the *upper* beds of the Skiddaw Slates. Again, at Mungrisedale, about two and a half miles to the north of this point, the Skiddaw Slates are seen in the form of hard, flaggy beds, with a few intercalated bands of grit, and very little affected by cleavage. They are not in any way metamorphosed, and they dip S.S.E. at about 60°, striking E.N.E. and W.S.W. right against the trappean range of Eycott Hill, which is less than a mile to the east. The north-eastern extremity, therefore, of Eycott Hill rests upon the *lower* beds of the Skiddaw Slates. From the above description it will be seen that there is the most complete discordance between the two formations; the strike of the two being at variance by as much as nearly 80°, whilst the dip of the lower formation is nearly double that of the superior.

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[1] I may mention that there occurs here a magnificent, porphyritic, and amygdaloidal trap, containing numerous crystals of felspar—some of which are more than half an inch in length—together with numerous cavities filled with calcspar or with chalcedony. It is, without exception, the most beautiful porphyry with which I am acquainted as occurring in the Lake-district. It is a very persistent bed, being seen at various points in the Caldbeck Fells, and occurring at Binsey Crag. At some distance above it, in the same section, there occurs an equally beautiful amygdaloidal ash.

[2] It is worth while noticing, in connection with a recent paper by Mr. Maw (GEOL. MAG. Vol. VI. p. 72), that the "lower drift," which he there describes as seen at Workington, occurs here, many miles from the coast, and at an elevation of several hundred feet above the sea-level. The section in question (at Greenah Moss) exactly resembles the one described by Mr. Maw, consisting of an inferior, very tough, blue clay, which contains boulders, and is overlaid by a red, loamy drift, containing, in greater abundance, fragments of the rocks of the Lake-district.

(II.) *Skiddaw Slates and Green Slates beneath the Penine Range.*—Commencing at the north-western extremity of the Lower Silurian area beneath the Penine chain, the lower beds of the Skiddaw Slates are seen at Mickle Aw Fell and in various parts of Rake Beck, near Melmerby, dipping S.S.E. at from 50° to 65°. Similar hard and flaggy beds are seen right under the base of Caterpellet Hill, dipping in the same direction at 65°, and directly surmounted by a green felspathic trap which forms the base of the Green Slates. This trap forms the mass of Caterpellet and rises on the N.E. into Cuns Fell, where it also reposes upon the lower beds of the Skiddaw Slates. On the south-eastern side of Cuns Fell, in Ousby-dale Beck, the upper, shaly beds of the Skiddaw Slates are seen dipping N.N.W. at 70°; and lower down the stream, immediately to the south-east of Caterpellet, similar beds are seen dipping N. at 65°. These are directly overlaid by a light-brown felspathic trap, containing crystals of felspar, which form the ridges to the S.E. of Ousby-dale. The appearance of the Skiddaw Slates in Ousby-dale Beck is probably due to a sharp anticlinal, but may possibly be produced by a fault. Be this as it may, it is clear that to the N.W. of Caterpellet, the trap which forms the base of the Green Slates rests upon the *lower* beds of the Skiddaw Slates, whereas to the S.E. of Caterpellet the same trap reposes upon the *upper*, shaly beds of the same. Further to the S.E. a similar felspathic trap is seen in Ashlock Syke, and again in Ardale Beck, resting upon the upper, shaly beds of the Skiddaw Slates, which appear to have a nearly vertical inclination. Still further to the S.E. the Skiddaw Slates are found occupying the Westmorland side of Crowdundale Beck, and extending from this stream to Knock-ore-gill Beck. In Crowdundale, and in its tributary Ellengill Beck, the upper, shaly beds of the Skiddaw Slates dip N.N.W. at 70°, and are overlaid by the porphyries of Moray and Grumpley Hills on the north. To the south the strata fold over, and in Knock-ore-gill Beck, on the S.E. side of Burney Hill, similar shaly beds are seen dipping nearly S. at from 50° to 60°. These are succeeded by the yellowish-brown felspathic trap of Knock Pike, which is in turn succeeded by a series of flaggy shales, which occupy Swindale Beck, and dip S.S.E. at about 45°. The remainder of the Lower Silurian area beneath the Penine chain offers nothing which bears specially upon the relations between the Green Slates and Porphyries and the Skiddaw Slates.

(III.) *Skiddaw Slates near the foot of Ulleswater.*—In a small area close to the foot of Ulleswater, the upper shaly beds of the Skiddaw Slates are seen in the lower part of Aik Beck, dipping S.S.E. at angles of from 50° to 60°. In the higher part of the stream, these are overlaid by the inferior portion of the Green Slate series, some of the beds consisting of coarse felspathic ashes, the dip of which can be satisfactorily made out to be S.S.E. at 40°. The inclination, therefore, of the Green Slates is in this locality considerably lower than that of the Skiddaw Slates beneath them.

(IV.) *Skiddaw Slates between Bampton and Shap.*—Proceeding up the river Lowther from Bampton to Shap three small areas of Skiddaw Slate are crossed, one at Rossgill, a second at Keld Beck, and the third in the course of Thornship Beck. In all these localities the upper shaly beds of the Skiddaw Slates are brought to the surface, and dip S.S.E. to S.E. at angles of from 45° to nearly 90°. In each case they are surmounted by the fine-grained, greenish-gray felspathic trap which forms the base of the Green Slate series, but the dip of this could not be determined.

Conclusion.—Having now surveyed all the localities in Cumberland and Westmoreland in which the Skiddaw Slates come into contact with the Green Slates and Porphyries—with the single exception of the Black Comb area—the following conclusions appear to be deducible as to the relations of the two formations:—

1. Where the inclination of the Green Slate Series agrees in *direction* with that of the Skiddaw Slates, the dip of the former is almost invariably lower in *amount*; the difference varying from a few degrees to as much as half the dip of the inferior formation.

2. The dip of the Skiddaw Slates, at the point where they are overlaid by the base of the Green Slates, is occasionally directly opposed in direction to the inclination of the latter. This is seen at the head of Mosedale Beck under Wolf Crags, and also in the course of Ellengill, near Overwater.

3. The strike of the Green Slates is sometimes at variance with that of the Skiddaw Slates. This is seen to a slight extent in proceeding from Troutbeck to Keswick, and again from Borrowdale in a S.W. direction towards the head of Buttermere; since the felspathic trap which forms the base of the Green Slate Series reposes at first upon the upper, shaly beds of the Skiddaw Slates, but seems gradually to become transgressive upon them, so as finally to rest upon beds which, though high in the series, are not the highest. It is also seen in Torpenhow Common, to the north of the foot of Bassenthwaite Lake. This phenomenon is, however, best exhibited on the N.E. margin of the great area of the Skiddaw Slates, where the two formations strike for a considerable distance nearly at right angles one to another.

4. As a consequence of the above, the base of the Green Slates reposes at one time upon the higher, and at another upon the lower beds of the Skiddaw Slates. This is seen near Melmerby, beneath the Penine chain, but it is much more strikingly exhibited on the N. and N.E. margin of the great area of the Skiddaw Slates. Thus at both extremities of this boundary, the base of the Green Slates reposes upon the soft black shales which form the summit of the Skiddaw Slates, resting between these points upon all the intermediate beds of the great anticlinal of the Skiddaw Slates, down to their base.

5. From the above we are warranted in coming to the conclusion that the Green Slates and Porphyries of the Lake-district are superimposed unconformably upon the series of the Skiddaw Slates.

Addendum.—Since the first part of this paper was published, I have found a single small section between the Vale of St. John and Keswick, in which the upward termination of the Skiddaw Slates is exhibited. This occurs about two miles to the S.E. of Keswick, close to the high road to Ambleside, near a place called Dalebottom, in the valley of Naddle Beck. Here a small stream flows down from a hill called the Pike, and exhibits in its lower portion a small exposure of the upper shaly beds of the Skiddaw Slates, which dip S.S.E. at 50°, and are directly overlaid by the fine-grained felspathic trap, which forms the base of the Green Slates.

NOTICES OF MEMOIRS.

I.—On the Existence of Rocks containing Organic Substances in the Fundamental Gneiss of Sweden.

THREE papers relating to the occurrence of certain vegetable substances in the Fundamental Gneiss of Sweden, have recently been communicated to the Royal Academy of Sciences at Stockholm.[1]

The *first* of these papers, by M. Igelström, which describes some beds of bituminous gneiss and mica schist that occur interstratified in common reddish granite-gneiss at the western part of the high and precipitous Nullaberg, was noticed in the GEOLOGICAL MAGAZINE, Vol. IV. (1867) p. 160.

M. Igelström considers that the Gneiss and Mica Schist of the Nullaberg must be ranked among the Sedimentary and Fossiliferous Strata.

In the *second* paper M. Nordenskiöld points out the principal ingredients in these bituminous rocks of Nullaberg,—they are a greyish-white orthoclase and silver-white mica, mingled with variable portions of a carbonaceous or coal-like substance. This carbonaceous substance is very brittle, and the rock is therefore more friable than common gneiss. The grains of orthoclase break along the cleavages of the felspar, and the fracture of the rock is thus crystalline.

He regards the rock as probably due to the solidification and crystallization of a clay-like sediment, consisting of organic substances and inorganic matter, of the same constituents as the common felspar; and he remarks, as a phenomenon not at all improbable, that a change in the relative position of the atoms, *i.e.* a crystallization in a solid mass tending to a disposition of its molecules, according to the best conditions of equilibrium, took place *without*

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[1] L. J. Igelström, On the occurrence of thick beds of bituminous gneiss and mica schist in the Nullaberg, parish of Ostmark, province of Wermland, in Sweden.—A. E. Nordenskiöld, Note on the mineral character of the rock.—F. L. Ekman, Chemical analysis of the rock.—Translated from communications read to the Royal Swedish Academy of Sciences at Stockholm.

the aid of water or heat[1] during the immense time that has elapsed since the Gneiss period. M. Nordenskiöld does not attempt any explanation of the way in which this change was effected.

M. Ekman, in the *third* paper, gives the result of analyses of various specimens of Nullaberg rock, which show it to be essentially a potash-felspar, with a little apatite, traces of manganese and copper, phosphoric acid and chlorine, besides the organic matter and carbonate of lime.

Whether this Fundamental Gneiss of Sweden is the equivalent of that in the Hebrides and of the Laurentian rocks in Canada and elsewhere, is a point not discussed in these papers.

Lithologically the Swedish beds appear very similar to the Laurentian Gneiss, containing graphite, described by Sir W. E. Logan, and which without doubt was originally a sedimentary rock. So long ago as 1846 M. Elie de Beaumont announced the sedimentary nature of the Swedish gneiss,[2] while the recorded discovery by Prof. Sismonda[3] of an Equisetum in gneiss (of Jurassic age), would leave no doubt about the original aqueous origin of the rock.—H. B. W.

II.—TRANSACTIONS OF THE EDINBURGH GEOLOGICAL SOCIETY. VOL. I. Parts I. and II. 1868. 8vo.

THESE Parts contain the papers read before the Edinburgh Geological Society between November, 1866, and May, 1868. Among the more important of these communications, the following may be mentioned:—On the Carboniferous Strata of Carluke, by J. R. S. Hunter; On the Geology of the Coasts of Antrim and Londonderry, by T. Smyth; On the old Red Sandstone of Scotland, by J, Powrie, F.G.S., etc.; On the Superficial Deposits at the South Esk, by Dr. J. C. Howden; On the Evidences of Glacier Action in Galloway, by W. Jolly.—There are numerous illustrations accompanying these papers, some of which have previously been noticed in the GEOLOGICAL MAGAZINE—the last report (of a meeting on April 2nd, 1868,) was published in the number for May last year.

The following papers were read on April 16th, 1868:—

1. Observations on the Miocene Beds of Greenland. By Robert Brown, F.R.G.S.

Extending over a very limited area, these strata are composed of a great variety of beds of sandstone, alternating with lignite, and capped by shales of various descriptions. In all the sandstones and shales vegetable impressions are found, but it is only in the thin layers of a hard clay-slate, impregnated with iron, that they retain their impressions very distinctly. All these strata are cut across by trap-dykes, which in some places stand out bare and wall-like from the denuded softer rocks through which they protrude.

The author protests against the way in which Professor Heer has been making species and genera out of the fossils discovered in these

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[1] It may be noted that Dr. T. Sterry Hunt has urged the presence of carbon in the state of graphite, *unoxidised*, in metamorphic rocks, as a proof that a temperature of ignition was not required for metamorphism.—Vide GEOL. MAG. Vol. I. p. 202.

[2] GEOL. MAG. Vol. I. p. 156.

[3] Ibid. Vol. II. p. 239.

Miocene Beds, though perhaps in placing too much importance on slender characteristics he does not stand alone; and he is glad to observe that Mr. Carruthers is doing the *synthetic* to other botanists' *analytic* subdivision of fossil species.

2. Brief Notes on the Precious Stones and Pearls of Scotland. By A. M. Cockburn.

Although poor in the more precious gems, Mr. Cockburn remarks that Scotland can boast of her jaspers, pebbles, agates, pearls, and of fine specimens of quartz; the moss agates are peculiarly suitable for certain styles of setting. Cairngorm stones are found in great abundance in the matrix of the granite on the top and sides of the Cairngorm Hills, in Aberdeenshire and Banffshire.

Amethysts and garnets may be ranked among the Scottish gems. The former is now becoming scarce; the latter is found in large quantities at Elie Point, and along the sands on the east coast of Fife.

Fine and large specimens of pearls are found in the rivers Teith, Forth, Dee, Don, Earn, Tay, Tweed, and the rivers of Ross and Sutherlandshire.

3. Remarks on Two Flints from Jubbulpore, Central India, and on the Flint Implements discovered there by the late Lieut. D. Swiney, R.E. By James Haswell, M.A.

The principal part of the collection (numbering 977 pieces) is now in the British Museum, and was described by Mr. John Evans, F.R.S., F.S.A., in a paper read before the Society of Antiquaries, 19th of January, 1865.

REVIEWS.

I.—Underground Life; or, Mines and Miners. By L. Simonin. Translated, adapted to the present state of British Mining, and edited by H. W. Bristow, F.R.S. Illustrated with 160 engravings on wood, 20 maps geologically coloured, and 10 plates of metals and minerals in chromolithography. 8vo. pp. 522. London: Chapman and Hall. 1869.

THIS is a work of a popular-scientific character, somewhat similar, both as regards the style in which the subjects are treated and in the kind of illustrations, to the volumes of Hartwig, Figuier, and other writers of that class.

The woodcuts are excellent specimens of art, but in many instances the subjects chosen for illustration appear to us quite unnecessary to the text. Such are the pictures of a stable in a mine, a consultation in a mine, a Californian gold-finder prospecting the ground, miners at prayer, etc.; while the pictures of explosions and accidents in mines might with advantage have been dispensed with, as they are eminently calculated to give one the horrors. We were somewhat surprised to find M. Simonin remark that "in no instance has any merely fanciful design been admitted." Under "fanciful," we should certainly include the woodcut of the Indian miner of Lake

Superior *in full mining costume* (page 471). We are reminded of the full court suit of the visitors to the King of the Sandwich Islands.

M. Simonin has made himself extensively acquainted with mining both in Europe and America, but still (as the translator tells us) he looks at the subject from a French point of view, and does not give any special prominence to the mineral industries of this country.

Mr. Bristow has furnished a great deal of new and valuable matter relating to British mining, and he has evidently done much to improve the work, principally in the shape of additions or interpolations. The revisal of some of the maps, and the addition of new ones, beautifully executed in chromolithography by Mr. J. B. Jordan, form important features in this new edition of M. Simonin's work.

The book is divided into three parts,—the first is devoted to Coal. Its origin is discussed, and illustrated with an ideal landscape of the Coal-measure period. The history of the discovery of coal, the manner in which coal is worked, the dangers to which miners are exposed, and lastly, the probable duration of our coal supply, are all treated of in this part. In the second part the metalliferous mines are taken into consideration, and, in the third, the "mines of precious stones."

The whole is agreeably written and interspersed with numerous anecdotes, and with accounts of the manners and customs of miners in various countries. It will doubtless prove an interesting work to the general reader; and although its bulk might deter some from attempting its perusal, it will really be found not so formidable a task as its weight would imply, so much of the text being interspersed with illustrations, and the type being bold and clear.

II.—TRÜBNER'S AMERICAN AND ORIENTAL LITERARY RECORD for February 15th, 1869, contains Notices of many new and important additions to the Literature of the day.

Three books deserve special reference here:

I. "The Myths of the New World; a treatise on Symbolism and Mythology of the Red Race of America;" by Daniel G. Brinton, A.M., M.D., etc. (London: Trübner & Co.).

Probably there is no savage stock possessed of finer legends and mythical history than the Red Indians; and the beauty of their similes, derived from Nature, has been well shown by Longfellow in his "Hiawatha," and by many other writers. The names of God are remarkably grand and impressive,—thus, "The Thunder Vase," "The Foam of the Sea animating the World," "Heart of the Sky," "The Soul of the World," "Lord of the Sky," "Mother and Father of Life," "Maker and Moulder of all," etc., etc. In no American myth is there any trace of a personality of evil, nor have they any word corresponding to devil in their language. Many of the native legends have a most wonderful similarity to the description given in Genesis of the Creation and the Flood. The book is full of interest for the Ethnologist.

II. "The Lifted and Subsided Rocks of America, with their In-

fluence on the Oceanic, Atmospheric, and Land Currents" is the title of a book, about to issue from the press, by Mr. Catlin, the well-known American traveller and Ethnographist, whose descriptions of the habits and haunts of the North American Indians will ever be associated with his name. From the extracts given of the author's discoveries we anticipate a more wonderful story than that of a voyage through the Grand Cañons of the Colorado River.[1]

Mr. Catlin has discovered the source of the Gulf Stream under the Rocky Mountains! but we will not anticipate.

III. The third important work noticed at length in "Trübner's Record" is by James Fergusson, F.R.S., "On Tree and Serpent Worship, or Illustrations of Mythology and Art in India, in the first and fourth centuries after Christ; from the Sculptures of the Buddhist Topes at Sanchi and Amravati." This grand work, prepared under the authority of the Secretary of State for India in Council, formed the subject of a most delightful lecture by the author, delivered before the British Association for the Advancement of Science at Norwich in August last, and subsequently before the members of the Royal Institution, Albermarle Street. This is another magnificent contribution to Indian literature in particular, and to Ethnology in general.

III.—PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY. Vol. III. Nos. 7, 8 and 9. September to December, 1868.

THE Geological articles contained in these numbers consist of short notices of excursions made to Dundry Hill and to Dundas, near Limpley-Stoke, where the members had the opportunity of examining the Middle and Upper Lias, the Sands, and the Inferior Oolite.

There is also a paper by Mr. W. W. Stoddart, F.G.S., entitled "Geological Notes from Norwich." But the author is evidently "out of his element." He states that the Red Crag is the oldest of the Pliocene beds, forgetting the Coralline Crag, which is seen to underlie it in several parts of Suffolk; and says, that at Bramerton he "picked up numbers of the little *Potamides* so well known in the Isle of Wight." We have never found any such specimens in this locality, nor anywhere else in the Norwich Crag; neither have we before heard of their being so met with. Without denying the possibility of such specimens being derived, as Mr. Stoddart appears to think, we would refer his *Potamides* to the *Cerithium punctatum* or some other form common to the Norwich Crag.

Mr. Stoddart places the Bridlington Crag, and the Chillesford Clay, between the Red Crag and the Norwich Crag. But in the section at Bramerton the Clay may clearly be seen overlying the Norwich Crag, and the Bridlington Crag is regarded by Mr. S. V. Wood, Jr. as much newer; he places it above the Lower Drift.

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[1] See Bates's Illustrated Travels (Cassell & Co., Part I., p. 8).

Mr. Stoddart is certainly rather bold, when he states that this Crag is of the same age as the Chillesford Clay.

There is no Red Crag in the section at Bramerton. The relations of the Norwich to the Red Crag have never been seen in section. By some authorities they are considered to be synchronous deposits. Mr. Stoddart is so well known for his successful geological work in the Bristol district, that we regret he did not devote a little more time to the Geology of Norfolk, and look up the literature, before attempting to write a paper on the subject.

Mr. Adolph Leipner gives an account of some of the Carboniferous Corals in the Museum of the Bristol Philosophical Institution, which he hopes to complete and bring before a future meeting of the Geological Section of the Society.

Number 9 contains:—(1.) Some *Notes on the late Movements of the Somersetshire Coast*, by Mr. F. C. Ravis. These notes form a supplement to a paper he communicated to the Society about three years ago. He prefaces them with some remarks on the Trap and Mountain Limestone of Woodspring Hill, considering that the injection of the trap was prior to the movement that caused the inclination of the beds, because in general outline it appears to conform itself to that inclination: he thinks it probably contemporaneous with the Limestone.

Mr. Ravis then proceeds to describe the raised beach of Woodspring. This evidence of upheaval furnishes strong proof of the encroachment of the sea, for a twenty feet rise of the land with a shelving beach would be equivalent to a considerable horizontal distance. At present the waves dash against the rocks immediately beneath the old beach.[1]

Ancient Sand hills or Dunes, some contemporary with, others from their greater elevation of earlier date than these beaches, are well seen on the northern slope of Worle Hill. Remains of Dunes occur above the raised beach of Birnbeck Cove,[2] which beach, from its height above the sea, may probably be of the same age as that at Woodspring.

Brean Down exhibits on its northern side at least two tiers of sandy accumulations, at similar heights to the terraces in Sand Bay. The heights of these Dunes above the mean sea-level range to 150 feet.

Brent Knoll, an isolated outlier of Inferior Oolite, about 500 feet above the sea-level, contains from fifteen to twenty parallel terraces arranged like the seats in an amphitheatre, varying in height from one to five feet, in breadth from one to two feet. They occur at elevations up to 400 feet. These are regarded by Mr. Ravis as due to the action of the sea, and he remarks that they may possibly be contemporaneous in formation with the highest and oldest portions of the Cheddar Cliffs, which Mr. Mackintosh[1] maintains were chiefly formed by marine agency.

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[1] See also a short paper by Mr. D. Mackintosh "On the Mode and Extent of Encroachment of the Sea on some parts of the Shores of the Bristol Channel," Quart. Journ. Geol. Soc. Vol. xxiv. 1868, p. 279.—EDIT.

[2] See paper by E. C. H. Day, GEOL. MAG. Vol. III. p. 115.

(2.) Mr. A. Leipner concludes his paper *on the Carboniferous Corals in the Museum of the Bristol Association.*

There is also a notice of the Proceedings of the Bristol Microscopical Society, of which Mr. W. W. Stoddart is the President. This gentleman contributes a paper entitled a *Microscopical Examination of the Water Supply of the Bristol Water Works Company.* The water is derived from streams which rise in the Mendip Hills, and he shews it to be as pure as any in the kingdom, at the same time asserting that no water procured from a town spring could be pure, as many examples from the City of Bristol tended to prove.—H. B. W.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. The Annual General Meeting of this Society was held February 19th, 1869, Professor T. H. Huxley, LL.D., F.R.S., President, in the chair. The Secretary read the Reports of the Council, of the Library and Museum Committee, and of the Auditors. The general prosperity of the Society, as evinced by its financial position and by the continued increase in the number of its members, was stated to be very satisfactory.

The President presented the Wollaston Gold Medal to Henry Clifton Sorby, Esq., F.R.S., and stated that in awarding the medal to him, the Council desired to testify their appreciation of the value which they, in common with all other geologists, attach to Mr. Sorby's laborious investigations, continued now for a period of more than eighteen years. The President referred especially to Mr. Sorby's researches into the structure of rocks and minerals, and of meteorites; to his explanation of the phenomenon of slaty cleavage, now universally adopted and fully in accordance with the results obtained by physical investigators who have approached the same question from a very different side; and finally remarked upon the peculiar fitness of the award of the Wollaston Medal to a worker possessing so much of that love of minute research, and so much of that power of elucidating the great by the little which characterised its illustrious founder.—Mr. Sorby briefly returned thanks for the honour conferred upon him by the Council, and remarked that although his investigations had been the result of a pure love of science, without expectation of fee or reward, such a recognition of the value of his services could not but be most grateful to him, and would encourage him to proceed further on the same path.—The President then presented the balance of the proceeds of the Wollaston Donation-fund to Wm. Carruthers, Esq., F.L.S., F.G.S., of the British Museum, in aid of his researches in Fossil Botany, remarking, especially with regard to those directed towards the structure of Fossil Fruits, that these are so valuable that Mr. Carruthers might justly look upon the award as an expression of gratitude for his labours. At the same time the President observed that scientific gratitude was of the kind which had been defined as a lively sense of favours to come.—Mr. Carruthers returned thanks for the honour conferred upon him, and said that whilst he could not consider himself entitled to any such recognition of his services to science, the award of the Council would be both an aid and an encouragement to him in the further prosecution of his researches.—The President then proceeded to read his Anniversary Address, in which he discussed the present position of Geology in this country, and the various geological speculations which are now more or less in vogue, and combated the assertion which has been made, that geological speculation in this country is opposed to the principles of Natural Philosophy. The Address was prefaced by biographical notices of recently deceased Fellows, including the Rev. S. W. King, M. Boucher de Perthes, of Abbeville; M. Morlot, of Berne; Principal J. D. Forbes, F.R.S., of the University of St. Andrews; Sir David Brewster, K.H., F.R.S., Principal of the University of Edinburgh; the Rev. J. G. Cumming, etc.

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[1] Intellectual Observer, August, 1867, p. 30.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year: *President*: Prof. T. H. Huxley, LL.D., F.R.S. *Vice-Presidents*: Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; Sir R. I. Murchison, Bart., K.C.B., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Rev. T. Wiltshire, M.A., F.L.S. *Secretaries*: P. Martin Duncan, M.B., F.R.S.; John Evans, Esq., F.R.S. *Foreign Secretary*: Prof. D. T. Ansted, M.A., F.R.S. *Treasurer*: J. Gwyn Jeffreys, Esq., F.R.S. *Council*: Prof. D. T. Ansted, M.A., F.R.S.; W. Boyd Dawkins, Esq., M.A., F.R.S.; P. Martin Duncan, M.B., F.R.S.; Sir P. de M. G. Egerton Bart., M.P., F.R.S.; John Evans, Esq., F.R.S., F.S.A.; David Forbes, Esq., F.R.S.; J. Wickham Flower, Esq.; R. A. C. Godwin-Austen, Esq., F.R.S.; Harvey B. Holl, M.D.; Prof. T. H. Huxley, LL.D., F.R.S.; J. Gwyn Jeffreys, Esq., F.R.S.; Prof. T. Rupert Jones; Sir Charles Lyell, Bart., D.C.L., F.R.S.; John Carrick Moore, Esq., M.A., F.R.S.; Prof. John Morris; Sir R. I. Murchison, Bart., K.C.B., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Earl of Selkirk, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Alfred Tylor, Esq., F.L.S; Rev. Thomas Wiltshire, M.A., F.R.A.S.; Searles V. Wood, Jun., Esq.; Henry Woodward, Esq., F.Z.S.

II.—*Ordinary Evening Meeting,* February 24th, 1869.—Paper read "On the British Post-glacial Mammalia." By W. Boyd Dawkins, Esq., M.A., F.R.S, F.G.S.

The author stated that the Post-glacial or Quaternary Mammalia of England and Wales amounted to 47. Of these only 15 are found in Caves and not in River deposits, whilst out of 31 found in the latter, one, only, does not occur in caves; hence the author inferred that the Cave and River deposits are palæontologically synchronous. In Scotland remains of Mammalia have occurred only in five places, and in Ireland only in two places, in beds of Post-glacial age. The author ascribed this unequal distribution to the long continuance of subaërial glaciation in Ireland, Scotland, and North Wales.

The author then compared the Post-glacial with the Pre-glacial Mammalia. The British species of the latter are :—

Ursus arvernensis.
—— *spelæus ?.*
Sorex.
Mygale moschata.
Talpa europæa.
Cervus megaceros ?
—— *capreolus.*
—— *elaphus.*
—— *Sedgwickii.*
—— *Ardeus.*
Bos primigenius.
Hippopotamus major.
Equus fossilis.
Rhinoceros megarhinus.
—— *Etruscus.*
Elephas antiquus.
—— *meridionalis.*
Arvicola amphibia.
Castor fiber.
Trogontherium Cuvieri.

Of these 19 species inhabiting Britain before the deposition of the Boulder-clay, 12 survived into Post-glacial times.

Passing from Post-glacial to Prehistoric time, the Sheep, Goat, *Bos longifrons*, and Dog make their appearance, while the great Pachydermata, the Cave Mammals, and nearly all the northern forms disappear. The characteristic Post-glacial Mammals were defined by the author to be—

Palæolithic man.
Gulo luscus.
Ursus spelæus ?.
—— *ferox.*
Felis leo.
—— *pardus.*
Hyæna spelæa.
Ovibos moschata.
Rhinoceros tichorhinus.
Elephas primigenius.
Lemmus.
Spermophilus citillus.
—— *erythrogenoides.*

The author finally discussed the question of the age of the Lower Brick-earths of the Thames Valley and Clacton, and indicated the difficulty of proving, from Palæontological evidence, whether they are Pre- or Post-glacial. He supposed that during the Glacial submergence, the valley of the Lower Thames roughly marked the coast-line of the icy sea, with a climate too cold to allow the continued residence of the Pre-glacial mammals, but which might still occasionally be visited by their surviving descendants, the remains of which would thus be mingled with those of Arctic immigrants.

Discussion.—The President suggested that a fourth period might be added to the three adopted by the author, viz., the Glacial period, during which it would appear from the paper that some animals may have lived in Britain.

Mr. Busk thought that some of the animals of the Post-glacial period, such, for instance, as the Hyæna and Lion, were of southern, and not, like many of the others, of northern and eastern origin. The Lynx also might not improbably be of African descent. It was abundant in the bone breccia of Gibraltar, as was also the *Cervus elaphus*. *Hippopotamus*, *Elephas antiquus*, and possibly *Rhinoceros*, might also be regarded as southern forms; and it was worth consideration whether the fauna might not be connected with the time when Southern Europe was joined on to Northern Africa.

Mr. Tate stated that at Carrickfergus there was a Forest-bed underlying Glacial drift, from which possibly the Elephant remains found there had been derived.

Mr. J. W. Flower objected to all the fossils attributed to the Post-glacial period being regarded as synchronous, and to the cave- and river-deposits being classed together.

Mr. Evans hoped that at some time a chronological arrangement of British caves might be proposed. He mentioned the discovery of a palæolithic flint implement in a brickfield at Highbury, and argued against the lower level deposits of the Thames valley being regarded as more ancient than the higher.

Mr. Topley called attention to the absence of river-gravels and caves in the Silurian region of Wales and of the north, which was owing mainly to the absence of limestone adapted for the formation of caves and of material for gravels.

Prof. Ramsay argued that caves such as those in which Mammalian remains occur must have existed in Pre-glacial time, and therefore that it would be strange if none of those explored contained Pre-glacial remains. He was not satisfied as to the cause of the Thames forming a line of demarcation marking the absence of Glacial deposits. It could only be accounted for in his mind by the valley of the Thames having been entirely excavated since the Glacial period, though he acknowledged this was a bold speculation. He had always regarded the Thames valley deposits as Post-glacial.

Mr. Whitaker had been brought to the conclusion that the brick-earth of the Thames valley belonged to the latter part of the Post-glacial period. Beneath the *Corbicula* beds of Erith were the remains of *Pisidium* and many of the common recent species of the neighbourhood. He saw no such extreme difficulty in the excavation of the Thames valley since the deposition of the Boulder-clay. (See Letter, p. 188.)

Mr. J. Gwyn Jeffreys mentioned the *Helix ruderata* and *H. fruticum* as being instances of shells of northern character occurring in the Thames valley at Ilford. No shells of an Arctic or Boreal character occurred in the south of England, so that it would appear that it had not been submerged.

Mr. Prestwich was glad to find that the opinion of the Thames valley deposits being Post-glacial was gaining ground. He called attention to the existence in France of river-gravels belonging to an earlier period, such as that near Chartres, so that such might exist elsewhere. He could not reconcile the occurrence of *Hippopotamus* so far north as Leeds with its annual migration, as had been suggested.

Mr. Godwin-Austen agreed with the view of the author of the "Reliquiæ Diluvianiæ," that the animals whose remains occur in caves lived prior to the submergence which filled the caves, or, in other words, to the Glacial period. He thought that it was impossible for all the animals whose remains occurred in the river-gravels to have occupied the land surface at the same time. He considered that English geologists were too prone to argue from phenomena confined to this country. A long island must have existed where now is the south of England, at the Glacial period; and he thought that at that time all animal life must have ceased there. If so, our divisions of time could not apply to the continent, where no such extreme changes in conditions took place.

Mr. W. Boyd Dawkins, in reply, admitted that possibly some animals classed as Post-glacial belonged also to the Glacial period; but for convenience sake he had adopted the three divisions in the paper. He saw no necessity for any of the animals being of purely southern origin. He did not identify the Lower Brick-earth of the Thames valley with the other river-deposits, though from the presence of the Musk-sheep, he was inclined to place them later than at one time he did. The only reason he could give for the absence of Pre-glacial caves both in England and on the continent was, that the rocks containing them may have been removed by denudation.

GEOLOGICAL SOCIETY OF GLASGOW.—I. This Society met on the evening of January 5th, Mr. Edward A. Wunsch, V.P., in the chair.

The Rev. Henry W. Crosskey exhibited a small block of limestone, bored by *Pholas*, from Great Orme's Head, which he had lately visited in company with Mr. R. D. Darbishire, of Manchester. He described the position and peculiarities of the supposed *Pholas* borings. The specimen exhibited was from a height of 570 feet. The preservation of the *Pholas* burrows in the position in which they are now found, proves that the elevation of the land must have taken place since the Glacial epoch.

Mr Edward Hull exhibited some specimens of pebbles from the New Red Conglomerate (Trias) of Central England, in the neighbourhood of Burton-on-Trent. The majority of these pebbles were stated to be composed of purple, pink, or "liver coloured" quartzite, while a few pebbles of local origin from the Carboniferous rocks also occur. The quartzite pebbles are invariably rounded and water-worn, and never of large size; they cannot be referred to any formation known to exist in England. From the manner in which they are distributed in England, Mr. Hull was of opinion that they had their origin to the northward of the Central Counties: and recently he had observed that the Lower Old Red Conglomerate of several parts of Scotland was composed of precisely similar pebbles of quartz rock, as those of the New Red Conglomerate of England. The Conglomerate of Lesmahagow, for instance, described by Sir R. I. Murchison in 1856, (Quart. Journ. Geol. Soc., vol. xii.), is almost entirely composed of these pebbles, sometimes attaining a diameter of 16 inches. At Balmaha and Aberfoyle it presents similar features, but westward, as at Gairloch, the pebbles are of a more local character, though also containing the coloured quartzites, as described by Dr. Bryce. Mr. Hull felt satisfied that the New Red Conglomerate of England was the daughter of the Old Red Conglomerate of Scotland.

Mr. Robert Craig, of Langside, near Beith, read a paper on "The Geology of the Dalry District." The area described is the triangular basin situated in the parishes of Dalry, Kilbirnie, and Beith, the south-west angle of which extends into the north of Kilwinning, and has narrow extensions, one north-east into the Castle-semple Valley, the other into the Lugton Valley to Shellord. After defining the boundaries of the basin, and giving a sketch of the Trap hills which surround it, Mr. Craig minutely described the Limestone series, as developed in the neighbourhood of Beith, consisting of limestone, shale, sandstone, thin seams of coal. etc., which also crop out in the beds of the various streams which descend from the hills on the opposite side of the valley with similar lithological characters. The author next described the various sections exposed at Rye Water, Auchenskeigh, Auchenmeade, and other localities around the basin. The underlying beds of the district are rich in fossils, chiefly *Brachiopoda*, some beds three feet in thickness being entirely composed of *Producti*. A band of limestone two feet thick at Broadstone is made up of a coral (*Lithodendron*), while other beds have yielded numerous specimens of the teeth and fin-rays of fishes. The Boulder-clay is well seen in almost every quarry in the district. It is full of erratic boulders derived from a northern source. Sections examined by Mr. Craig between Kilwinning and Barrhead—a distance of 15 miles in the supposed line of the glacier—led him to conclude that about 80 per cent. of the boulders had not travelled more than five miles. Thus, at Auchenskeigh, the majority are of sandstone from rocks situated two and three miles to the north-east; at Roughwood, they are from the Broadstone limestone; and in the railway cutting east of Shelford the boulders are traps from hills to the east and sandstones from the Levern Valley, two miles distant. Mr. Craig concluded with a description of the numerous Greenstone dykes which intersect the strata from north-west to south-east in various parts of the district.

II. The next meeting was held on the evening of February 4th,—

Professor John Young, M.D., F.R.S.E., F.G.S., President, in the chair.

Mr. James Thomson, F.G.S., exhibited several specimens of chlorite schist from Port-Askaig, Islay, with imbedded angular and rounded fragments of granite, varying in size from one-eighth to twenty inches in diameter. Mr. Thomson was not aware that granite had been found *in situ* in the island, consequently the pieces must have been transported from a distance, probably by ice, and imbedded in the chlorite schist during its deposition. The granites are of two kinds, one resembling a fine-grained variety of a dull red colour found in Glencoe, the other resembles the granite of the Ross of Mull. If the presence of these granites might be attributed to the agency of ice, it would imply a Glacial period during the deposition of the schistose rocks of the Western Highlands.

Mr. Thomson also exhibited a large suite of fish and reptilian remains from the blackband ironstone of Quarter, near Hamilton, which the President pointed out in detail, and expressed a desire that they might be figured and described in the publications of the Society.

Mr. Hugh M'Phail, of Nitshill, read a paper on "the Carboniferous Sections of the Levern Valley," illustrated by a cross section from Waukmill Glen to Crookston Hill, representing the succession of the beds from the Hurlet and Nitshill main coal series upwards. The valley of the Levern is divided into two portions, the southern being drained by the Aurs, joined by the Brock, and the northern by the Levern, the natural trough of the valley being in the southern division. Commencing at a brown sandstone, a few feet from the surface in the centre of the trough, Mr. M'Phail described the lithological character of the different strata down to the base of the section, embracing upwards of three hundred fathoms. The strata on the southern side of the valley rest upon the Trap, and on the northern side at Crookston they are much altered by an igneous dyke. Four great faults traverse the valley in a direction nearly east and west, which are crossed by smaller faults at various angles. These have produced upthrows of the strata to the westward. As the valley narrows towards the west the strata attain a high angle, and are gradually thrown off, and in the bed of the Levern at West Arthurlie, Gateside, and near Broadley Mill, they are seen dipping at various angles. The geological phenomena along the south of the valley, and at the base of the Fereneze and Brownside hills, strongly indicate that the Trap has been elevated through the Carboniferous strata. It would appear from the angles at which the faults cut the trough that they could not have been formed by a depression of the valley; but, viewed in connection with the smaller cross faults, it seems evident that an upheaval of the igneous rocks has taken place on both sides of the valley, The ranges of hills above referred to appear to have had a greater elevation than they now possess, and to have been again depressed, carrying down with them the strata on and adjacent to their base. From the formation of the trough, Mr. M'Phail was of opinion that the beds had been deposited on elevations on each side of the valley, and that these elevations were at a lower level, or at a greater distance from the trough, than the traps now are. By whatever causes these great displacements have been occasioned, whereby the northern division has been elevated to its present position, it must have been since subjected to extraordinary denudation; for immediately after the displacement of the strata, the northern division must have been at least 1500 feet above the present bed of the Levern near Hurlet. After the elevation, the bold escarpments formed would probably be directly in front of the denuding agent, as suggested by the Glacial striæ at Oldbar and Crosstobs, to which they would soon give way on account of the thick beds of clay shale of which they were composed. At the western extremity of the valley the Glacial striæ are due east and west, showing that by this outlet between the traps had flowed the denuded *debris*. The origin of the Sandstone boulders found to the westward of the Levern would thus be accounted for.

III. The third ordinary meeting was held on the evening of 4th March—Professor John Young, President, in the chair.

Mr. J. Wallace Young exhibited specimens of hematite from the mines recently opened in the Garlton Hills, a series of low-lying eminences in the north of Haddingtonshire, consisting principally of grey and reddish claystone. The farmer on that part of the property where the mines are situated, had frequently observed pieces turned up with the plough. It crops out almost at the surface, and from an examination of part of the workings to which Mr. Young had access, he was of opinion that it was a very valuable deposit. Two specimens which he had analysed showed—No. 1. Peroxide of iron, 89·64, equal to 62·75 metallic iron; No. 2. Peroxide of iron, 89·28, equal to 62·50 metallic iron. Hematite, when pure, consists solely of peroxide of iron.

The Rev. Henry W. Crosskey, F.G.S., and Mr. David Robertson, communicated a paper on the "Post-Tertiary Fossiliferous Beds of Scotland." The new localities which they had recently investigated are:—1. Blackburn, Tarbert.—On the north side of Tarbert loch, at the north-east corner, is a bed of clay, containing Arctic shells, traceable 12 to 15 feet above high water. It has an incline of 1 foot in 10, and is overlaid by six feet of stony mould. *Trochus helicinus* is peculiarly abundant, and many specimens retain their colour. *Mya truncata* does not occur whole, but the fragments are covered with fresh-looking epidermis. *Tellina calcarea* is neither plentiful nor large. Water-worn shells and those of different habitats are mingled together, showing that they have not all lived and died in the locality where they are found. This bed has, however, some characteristic species, especially of *Entomostraca*. The only British example of *Cythere emarginata* hitherto known was dredged by the authors in deep water off Shetland, but in this deposit the species is moderately common. *Pseudocythere caudata* of Sars, rare in England, Scotland, Ireland, and Norway in deep water, is here moderately common. 2. West Tarbert Deposit.—This clay extends along the south side of the loch, and at points abuts against the native rock, to which, in some cases, *Balani* and *Serpulæ* are actually attached in considerable abundance. Many of the shells have attained a particularly large size, especially *Tellina calcarea* and *Pecten Islandicus*. About twenty-four species of *Ostracoda* and sixteen of *Foraminifera* occur, comprising some new forms. 3. Crinan.—This bed is on a small plateau on the north side of No. 11 Lock, Crinan Canal. The section is exposed in a cutting made to lead off the water from the high level. A few feet only of the clay are exposed, and the shell-bearing portion is only a thin stratum. The shells are few and broken —the *Balani* more abundant than the shells, and mostly fragmentary. A perfect specimen of *Verruca stromia* was found. Thirteen species of *Ostracoda* occur, and all the species, except one or two, are tolerably abundant. There are ten species of *Foraminifera*, two being as yet undetermined. This deposit is thirty feet above the sea, and is of considerable interest. 4. Duntroon.—This clay is to the south of Duntroon Castle, coming to the surface at about high-water-mark. *Pleurotoma pyramidalis* is remarkably abundant. This bed contains thirty-seven species of *Ostracoda*, and thirty-three of *Foraminifera*, of very interesting types. 5. Crofthead.—In the Crofthead freshwater clays, which are now the subject of much discussion, the authors had succeeded in discovering several species of *Entomostraca*. A *resumé* was also given of the Post-Tertiary deposits at Kilchattan, Kyles of Bute, Paisley, and Old Mains, Renfrew. J. A.

NORWICH GEOLOGICAL SOCIETY.—This Society commemorated its fifth anniversary by a Soirée, held at the Norfolk and Norwich Museum, on February 4th, the rooms of which were lighted up expressly for the occasion. The Museum contains—besides the magnificent Ornithological collections, contributed in great measure by Mr. John Henry Gurney—the original collection of Cretaceous and Crag Fossils belonging to the late Mr. Samuel Woodward (author of "The Geology of Norfolk," etc.), the fine collection of Crag Mollusca formed by the late Capt. Alexander; and, lastly, the magnificent suite of Mammalian remains from the Forest-bed of the Norfolk coast, presented by the Rev. John Gunn, F.G.S., the President of the Norwich Geological Society. The Soirée (which was attended by upwards of 200 persons), was rendered extremely agreeable by the number of microscopes, drawings, and specimens exhibited; and the President (the Rev. John Gunn), the Honorary Secretary (Mr. J. E. Taylor), Mr. Charlesworth, F.G.S., and Mr. Kitton, addressed the meeting on various Geological topics. Much credit is due to the Committee and to Mr. Reeve (the Curator of the Museum) for the successful carrying out of all the arrangements.

NATURAL HISTORY SOCIETY, MONTREAL.—On January 21st, Principal Dawson, LL.D., F.R.S., etc., delivered the first lecture of the "Somerville" course of Lectures. He took for his subject "Palæozoic Land Animals." After a general sketch of the great groups of deposits containing organic remains, the lecturer gave a more minute account of the Fauna and Flora of the Carboniferous epoch, especially describing the terrestrial reptiles, insects, and mollusks discovered in the Nova Scotian Coal-fields. Dr. Dawson's name is so intimately associated with the discovery of these interesting remains that we cannot imagine a fitter subject for so able a lecturer, or one to which he could do greater justice.

The Bath Natural History and Antiquarian Field-club held their third meeting on February 24th,—the Rev. L. Jenyns, President, in the chair, when papers were read by Mr. McMurtrie on "The Faults and Contortions of the Somersetshire Coal Field," and by Mr. Chas. Ekin on "Chemistry in connection with Geology." Mr. McMurtrie, whose practical knowledge of the Coal-measures to the south of the Kingswood anticlinal enabled him to speak with so much authority on the subject, gave a condensed account of the various coal beds divided into the upper and lower series by the intervening permanent sandstones. The main object of the paper was a minute description of the numerous disturbances and contortions to which the whole field has been subjected. The Farnborough "Fault," with a downthrow of 600 feet, and the great feature of the Somersetshire coal field, the Radstock "overlap fault" in the upper division, were the principal points dwelt upon. But the chief interest centred in the contorted, dislocated, and folded strata of the Lobster series in the lower division,—every conceivable variety of disturbance seems to have its focus here, and produces the extraordinary result of coal actually won *beneath* the Carboniferous limestone. The anomalous position of this patch of limestone was accounted for by the great upheaval to which the whole Mendip range has been subjected,—an upheaval which may have been either gradual or continued at long intervals, but of such vast magnitude and force as to cause the limestone and superincumbent sandstone to be *folded back* on themselves, so that the natural floor of the bed becomes the roof of the workings. Mr. McMurtrie, in conclusion, stated that the approximate and probable origin of these "faults" and contortions had been discovered by Mr. Moore in the existence of volcanic rocks in the Mendip anticlinal, and that the same agent which upheaved the Carboniferous limestone of the Mendips was, in his opinion, the source of the great disturbances in the adjoining Coal-basin. The date of this upheaval was, he considered, at the close of the Carboniferous period, and previous to the deposition of the New Red Sandstone, and other overlying secondary rocks. The horizontal position of these rocks, reposing on the upturned edges of the strata beneath, was given in evidence of this conclusion; and the fact that the New Red Sandstone has been deposited on a comparatively level surface would seem to indicate that great denudation had taken place after the disturbances to which the Coal-measures were subjected.—Mr. Ekin's paper on "Chemical Geology" was then read, and in it the author traced the changes that have taken place in our globe, from the time when it existed in space in a gaseous state to its condition at the present day; he showed how existing nebulæ were proved to consist of gases in a state of incandescence, and the probability of a nucleus now being formed among them, and discussed the possibility of the earth's formation in a similar way. As condensation proceeded, and the earth became first fluid and then gradually solid, he showed that we should have at the centre the dense metals and their compounds, and in the crust the lighter metals, and explained how it was that the sea was salt from the first beginning. With a view to elucidate this part of the subject, he entered at some length into the composition of the sun, whose condition now is strictly comparable with that of the earth in its earlier stages, and proceeded to show how exactly the metals and gases forming the sun's atmosphere are ranged according to their densities. Coming more to chemical geology proper, he showed how the first sedimentary rocks were formed from the débris of pre-existing rocks, and the later ones in turn from their débris. Alluding to the Bath hot-springs, he strongly advocated the theory of their heat being due to chemical rather than to volcanic action, and explained his reasons for believing that this action was owing to the oxidation of iron. Treating amongst other heads of metamorphic action and mineral veins,—of the first he demonstrated the probability of many of our metamorphic rocks being due to the heat produced by great mechanical disturbances, such as the crumpling up of strata, and not to contact with the interior heat of the earth; and of mineral veins he adduced arguments in proof of their not being due to volcanic action. In conclusion, he gave the results of a new experiment by Mr. Stoddart of Bristol, which demonstrated very clearly the formation of flints, and concerning which nothing was satisfactorily known.—H. H. W.

CORRESPONDENCE.

THE BOULDER-CLAY AND THE THAMES VALLEY.

SIR,—At the meeting of the Geological Society, on February 24th, some surprise was expressed at the fact of the Boulder-clay not crossing the Thames Valley. It comes down in places to the water level on the north bank (there the Thames Valley is older than the Drift), and occurs nowhere along a distance of (I believe) ten miles on the south bank. If, as seems highly probable, at the time when the Boulder-clay was being deposited north of the Thames, parts of Kent and Sussex were above water, the Thamas Valley could not have been many fathoms deep, and existed as a channel running east and west between an island to the south and a shoal to the north. Along this channel an east and west current would flow parallel to the northern shore of the island, and sufficiently strong to cut off all drift slowly travelling down from the north and prevent its ever arriving at the coast. Therefore we find no remains of it now.

J. LUCAS.

GEOLOGICAL SURVEY OF ENGLAND, UPPER TOOTING, S.W.
February 26, 1869.

DISCOVERY OF DAKOSAURUS IN ENGLAND.

SIR,—In the last number of the Quarterly Journal of the *Geological Society* appeared an abstract of a paper by Mr. Wood-Mason, claiming to make known the existence of *Dakosaurus* in England. I trust I shall not appear wanting in courtesy in noticing the paper now, instead of waiting till it is published in full. But as I should then have no more or less to say, I have thought it better to make known the fact that *Dakosaurus* has already been chronicled as an English fossil, so that when Mr. Wood-Mason publishes his paper, he may withdraw his claim to be its first discoverer.

In the Woodwardian Museum occur vertebræ, limb-bones, and teeth of a reptile, for which I had used and still use the name *Dinotosaurus*; and, in a controversial writing on the Potton sands, I had referred teeth (in no way to be distinguished from those in the Kimmeridge Clay) to the same genus. My friend, Mr. Walker, soon after found that these teeth, which he had originally referred to as of crocodilian character, were similar to those in the British Museum, for which Quenstedt had used the name *Dakosaurus*, and in his next paper in the Annals of Natural History, 1866, and in the British Association Reports, he chronicles the *Dakosausus* as an English fossil, and acknowledges the assistance of Mr. Henry Woodward in its determination. It also was found in the beds at Wicken (Upware), and duly enumerated in a paper on that locality by Mr. Walker in 1867, in the GEOLOGICAL MAGAZINE, p. 310.

It has been known to me for several years in several species, as characteristic of beds from the base of the Oxford Clay to the sands over the Kimmeridge Clay. HARRY G. SEELEY.

WOOWARDIAN MUSEUM, CAMBRIDGE.

"MIDDLE DRIFT" GRAVEL AT LOPHAM FORD.

SIR,—My friend Mr. Gunn originally pointed out to me the interest attaching to Lopham Ford, as a crucial test on the question of denudation. He now asks, "how, supposing the valley of Lopham to be attributable to either pluvial or fluvial denudation, supposing the watershed to have been ever (? always) on that spot, could the magnificent bed of valley gravel have been deposited on the bank, near the ford and the watershed?"

What will he say, when I reply that there is no such bed of valley gravel there at all? The gravel seen is the "Middle Drift," in which the valley is excavated. I examined it carefully, and came to that decided conclusion. As corroborative evidence I found in it a bed of whitish sand, containing abundance of the same minute organisms from the Chalk, which are so plentiful in the Glacial sand at Firgrove pit near Norwich, and in the railway cutting near Wells. These could hardly be abundant in a river-gravel in a valley not cut through the Chalk.

I need not reiterate that I do not attribute the excavation of this valley to pluvial or fluvial, but to Glacial action. The contorted condition of the superficial beds, or "trail," is extremely marked in the gravel pit on the Suffolk side at Redgrave.—O. FISHER.

HARLTON, CAMBRIDGE.

ELEPHAS MERIDIONALIS IN THE NORWICH CRAG.

Sir,—I must beg you to allow me space for a few additional remarks—Firstly, Mr. Gunn's "evidence" is, I may venture to say, without offence, undeniably *no evidence at all*, and the way in which Mr. Fisher uses it in building a theory is an example of a common method of the growth of error. Mr. Fisher is quite right in saying that Mr. Whincopp's collection does not contain *E. meridionalis*, nor do other equally fine collections known to me. Mr. Fisher abandoning *E. meridionalis* as a Red Crag fossil, observes—"The species, however, is abundant in the Norwich Crag, which is sufficient for my argument." I would ask here, what exactly is the mode of occurrence of *E. meridionalis* in the Norwich Crag? How many molars have been found, and in what parts of the Norwich Crag? The headquarters of *E. meridionalis* in this country are undoubtedly in the Forest-beds, and the few specimens which appear to have come from the Norwich Crag, may have been derived, or have come from a representative horizon of the Forest-bed. Why does Mr. Fisher speak of "Miocenes of the south" as furnishing derivata to the Suffolk bone-bed? Surely Miocenes of the north will satisfy the required conditions better.

Some of Mr. Fisher's paragraphs lead me to suppose that I have been understood as wishing to dispute the identity of the Red and Norwich Crags. This was not my intention. I quite believe that they shade off into one another—the more northern beds of the Upper Crags being newer than the southern; this rule holding good for the various localities of the Red Crag, as well as the Norfolk Crag. My object was merely to get the facts rightly stated. The truth is, that nothing is known of the terrestial mammalia of the Coralline, or Red Crag period, *i.e.*, of a fauna cœval with the marine fauna of those deposits, and I believe the same is true for the Norwich Crag. The contents of Mr. Gunn's stone bed have no more to do with the Norwich Crag than have the contents of the Suffolk Bone-bed (two species of *Mastodon*, *Rhinoceros*, etc., Cetacean bones and nodules of Plio-miocene[1] age,) to do with the Red Crag. I should much like to see a list of Mammalian remains in addition to the *Mastodon* teeth, found in Mr. Gunn's stone-bed. The *Mastodon* does not occur in this country with *Elephas meridionalis* at all—nor in France—and we may doubt if it does so even in the Val d'Arno, since the strata may have belonged to different horizons which furnished the one to the other. The relations of—1st, the *Mastodon*-fauna of the Suffolk bone-bed and Norfolk stone-bed; 2nd, the *E. Meridionalis*-fauna of the Forest-bed; and 3rd, the Marine-fauna of the Crags, have still to be worked out, and this can only be done by keeping the three quite distinct and adhering to fact. I think I have clearly shown that the *Mastodon*, *Cetacea*, etc., of the Suffolk bone-bed are older even than a deposit (the sandstone nodules) containing *Conus*, *Cassidariæ*, *Pyrula*, and *Isocardia*, in place of the more boreal forms of the Crags. The question arises as to whether the same is true of the *Mastodon* of the Norfolk stone-bed. The remains of the Forest-bed are in the hands of Mr. Boyd Dawkins, who doubtless will not allow them to be mixed up with Crag or Bone-bed specimens. E. Ray Lankester.

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[1] This compound is used to avoid offence.

Hampstead.

SUGGESTIONS ABOUT DENUDATION.

Sir,—Your number of this month (p. 109) contains a clever paper by Mr. Kinahan. With one exception, I agree with everything that he has said. The exception relates to what Mr. Mackintosh has dubbed "My hard-gorge and soft-valley theory." I think that Dr. Hooker's terraces are *patches* of alluvial plains (or river haughs) sliced into terraces, and not filled-up lakes. Alluvial plains, properly so called, are deposited by the overflow of rivers upon flat dry ground, and not in hollows like filled-up lakes. Take the engraving of Dr. Hooker's terraces. On the left of the river, as you look at it, are four terraces. Number them 1, 2, 3, 4 from the river. No. 1 is now being formed in precisely the same way as all alluvial plains, and as all the preceding terraces have been formed. That is, by deposit from the overflow of the river on to the dry flat surface of the terrace, which also receives the waste of the sides of the valley and of the old terraces. No. 2 forms the banks of the river when in flood, and is *vanishing* now in precisely the same way as the preceding terraces have vanished. That is, the flooded river pulls the loose banks down, till No. 2 is driven against the side of the hill as No. 3 has been driven there. No. 1 then extends to the hill-side, and is added to by every flood till the bed of the gorge is lowered. Then No. 1 shares the fate of No. 2, 3, 4, and a new alluvium is formed at a lower level and at the expense of No. 1. Mr. Kinahan asks "what causes the barrier?" Any comparatively hard strata which cross the stream below softer strata. Even the

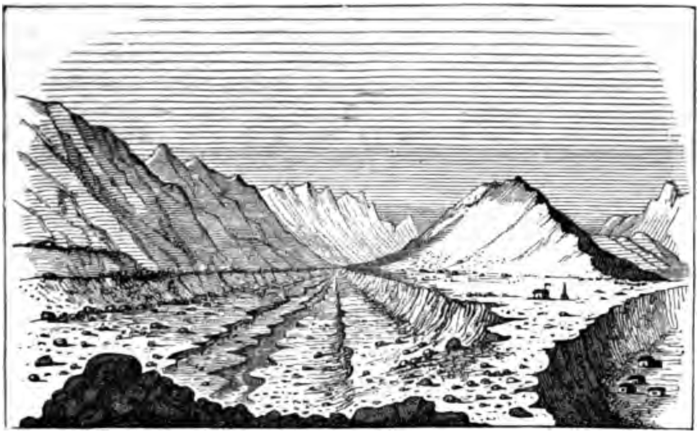


Diagram of the Glacial Terraces at the Fork of the Yangma Valley (copied, slightly reduced in size, from Dr. Hooker's Himalayan Journals, vol. i. p. 219).

soft Chalk of the North and South Downs form narrow gorges below the broad alluvial flats of the *softer* Weald Clay. But these Weald Clay flats are at the same level as the beds of the Chalk gorges. There are no hollows or lakes above the gorges.

The origin of all alluvial plains, properly so-called, is the stoppage of the lowering of the bed of the valley. The bed of the valley above the stoppage is then cut back perfectly horizontal at the level of the stoppage. The rain flood-water from the *inclined* sides of the valley is then checked, overflows and deposits on the *horizontal* part. The sea stops the lowering of the bed of every valley. Therefore, the parts next the sea are composed of horizontal alluvium. Take the alluvial plain of the Nile from Cairo to Syene. We know that it is raised by deposit every year. But this rising is not the result of a lake "behind a barrier." This rising of the lowest or marine alluvial plain is constant, that is, it will go on as long as the relative level of the land and of the sea remain the same, and no terraces will be formed. Parallel terraces are formed by *patches* of alluvial plain. That is patches formed in valleys cut in soft strata above gorges of hard strata, which make *temporary* stoppages of the lowering of the bed of the valley. But we do not require (as Mr. Kinahan supposes) "power to scoop out rocks behind a barrier" lower than the barrier. No hollow or lake is formed. The alluvial flat above the gorge is never lower than the bed of the gorge, it is at the same level, or, if anything, a shade higher. This principle accounts for the Kames at Carstairs above the gorges of the Clyde at Lanark, and of the Mouse Water at Cartland Crags, and I *guess* it would explain the enigma of the Eskers of Central Ireland.

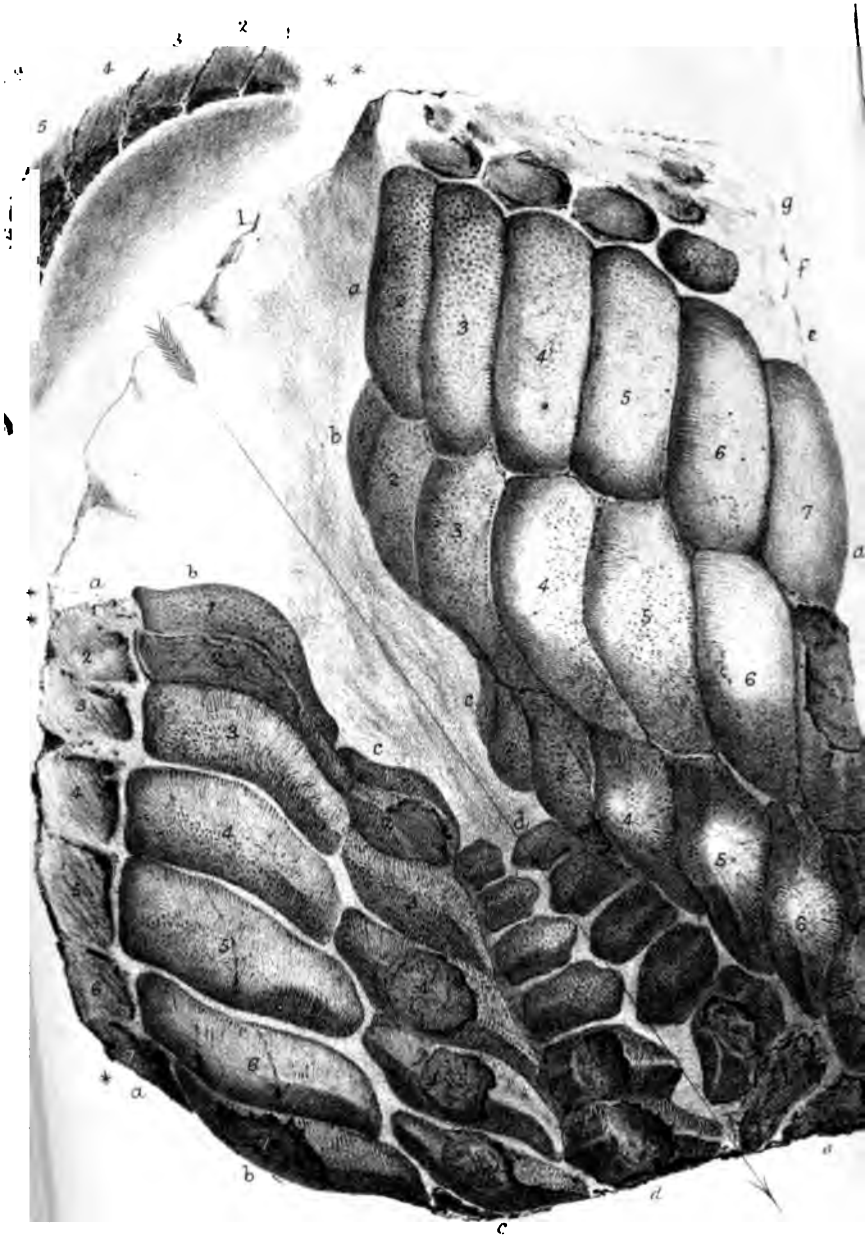
George Greenwood, Colonel.

Brookwood Park, Alresford, *6th March*, 1869.

MISCELLANEOUS.

GEOLOGY OF ALASKA TERRITORY.

Mr. Henry Walter Bates, Secretary to the Royal Geographical Society, has kindly forwarded me the subjoined extract from a letter of Mr. W. H. Dall, Smithsonian Institute, Washington, U.S. to F. Whymper, Esq., Haslemere, Surrey:—"*Alaska.*—You can tell your scientific friends that I have settled the geological question by fossils which I got this last year near Topanica (Norton Sound): a fine species of *Platanus*, which is undoubtedly Miocene Tertiary; there are no older rocks below Nuclukayette (Yukon River). The south flanks of the Alaskan range have Triassic? and Miocene Tertiary beds."—Mr. Dall's large collections are now being arranged at the Smithsonian Institute.



hodus from the Oolite of Caen

THE

GEOLOGICAL MAGAZINE.

No. LIX.—MAY, 1869

ORIGINAL ARTICLES.

I. Description of a great part of a Jaw with the Teeth of *Strophodus medius*, Ow., from the Oolite of Caen in Normandy.

By Professor Owen, F.R.S.

(PLATE VII.)

I HAVE not hitherto seen any specimen so satisfactorily and finely illustrative of the affinity of *Strophodus* to *Cestracion* as that figured in Plate VII. and which is now in the British Museum. It consists of the major part of the dental covering of a jaw, including the posterior part of the symphysis, and shows that the principal or largest crushing teeth are in two rows, in each ramus, the hinder one the largest, as in *Cestracion*. These are followed by two rows (at least) of smaller crushing teeth, and are preceded by rows of teeth both smaller and more produced at the middle of their working surface, and in the same degree changing from the crushing molar to the conical prehensile type. This dental coating or armature is imbedded in a block of the fine Oolitic building-stone from Caen, which has taken the place of the dissolved cartilaginous support of the teeth, so as to maintain and exhibit the curve of the arch (Fig. 1*a*) by which the teeth obliquely overspanned the jaw to which they were originally attached.

Of the principal row of teeth (*a*), six are preserved entire on one side, and the basis of seven on the opposite side of the jaw: the hinder half of this series has been broken off; the fracture of the supporting matrix there demonstrating the curve of the convexity of the jaw to which they were originally attached. Seven (Fig. 1*a*, 1–7) is thus shown to be the normal number of these large crushing teeth, which succeed each other from within, outward, and forward: it is the shell of the innermost and last formed which is wanting on the left side of this jaw.

The second tooth, counting from behind, on this side (*a*2), with a grinding surface 0·035 m. m. in length, 0·013 m. m. in breadth, has that surface moderately convex transversely, with the convexity highest toward the fore end, in the longitudinal direction: the outer and inner borders straight and parallel; the fore and hinder borders curved, but so as to indicate a low angle, fitting the interspace of the correspondingly shaped ends of the two teeth of the contiguous row. The main part of the crown is sculptured by an extremely fine network of thin ganoin, the meshes simulating pores; but toward the hinder slope the threads run together to form fine sub-parallel ridges which descend to the margin of the crown. There is a like disposition along the fore part of the tooth, but the parallel ridges are formed much nearer the margin, and are much shorter than those behind. The third, fourth, and fifth teeth, *a* 3–5, closely resemble the second; the sixth tooth shows the effects of mastication, the threads are worn down to the bottom of the meshes on the most prominent part of the grinding surface, and the meshes are shallower over a greater extent of that surface. In the anterior (seventh, 7 *a*) tooth abrasion has rendered a still greater proportion of the surface smooth, demonstrating how the ganoin closes the summits of the medullary or vascular canals.[1] The unworn meshes of the reticulate ganoin are so minute and deep as to look like pores. The marginal parallel ridges, out of the field of work, of course remain. The six teeth in place preserve the form and dimensions of the innermost: each in succession is moved forward, or toward the symphysis, about 0·004 m. m. in advance of the inner tooth.

The teeth of the row, *b*, next in advance are seven in number, and are preserved on both sides of the jaw: they do not show so close a resemblance to each other in size and shape as those of the row behind; in comparison with which they are smaller, more convex in the direction of the length of the grinding surface, and the highest part of the convexity is at the middle of the surface: the anterior end of the tooth is narrower than the posterior end, and in a greater degree in the innermost tooth than in the rest; this character, with the greater longitudinal convexity, gives the appearance of the tooth being bent obliquely lengthwise with the smaller anterior end inclining to the outer side of the jaw. The resemblance of the tooth, especially of the posterior ones, both in shape and superficies, to a contracted medicinal leech, is close, and accounts for the name given by the quarrymen to the detached fossils. The length of the working surface of the third tooth, *b* 3, in a straight line is 0·031 m. m.; the breadth of the hind border is 0·013 m. m.; that of the front border is 0.010 m. m. The posterior parallel linear disposition of the ganoin is proportionally greater as compared with its minutely reticulate disposition than in the larger teeth of the row behind. In the sixth tooth the summit of the convexity is worn smooth. In the seventh tooth, part of the crown has been broken away, on both sides of the jaw.

Eight teeth of the row, *c*, next in advance are preserved on the left side of the jaw: they diminish in greater degree, in size, than do those of the row *b* compared with *a*; they rise higher and more abruptly at the middle of the crown; the anterior end is more contracted; the inferiority of size of the innermost as compared with the rest is greater. A low ridge is continued from the summit of the crown to the ends of the tooth, that to the fore end being more marked than the one behind, and the anterior ridges are more prominent in the outer teeth of the row, *c*. 5, 6, 7, than in the inner teeth, 1–4. The length of the working surface of the fourth tooth, *c*, 4, is 0·028 m. m.; the breadth is 0·011 m. m.

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[1] As shown, in section, magnified, in plate xx. of my 'Odontography.'

Eight teeth of the foremost or symphysial row of teeth, *d*, are preserved on the left side. The exposed parts of the working surface augments from 0·008 m. m.—the longitudinal diameter of the innermost, *d*, to 0·020 m. m. that of the sixth tooth in advance. The degree of convexity of the grinding surface increases from the innermost to the fourth; in advance of this, the ganoin coating has been more or less broken away; in the fifth and sixth teeth, the ridge continued from the convexity to the ends of the teeth becomes marked, and more strongly as the tooth advances in position. The right and left teeth of this foremost series are alternate, and loosely interlock at the mid-line of the symphysis.

The parallel ridged disposition of the ganoin occupies the greatest proportion of the crown in the teeth of the anterior row; the reticulate disposition, rather coarser than in the large posterior teeth, is confined to the obtuse summit of the crown.

Returning to the hind part of the dental series, the largest row first described is succeeded by one, *e*, of very small teeth, with a uniformly convex grinding surface of an oblong elliptical form, of which the long diameter, in the direction from within outwards, exceeds that from before backwards. The long diameter is 0·011 m. m.; the short diameter is 0·008 m. m. The reticulate pattern prevails over their surface; it is coarser or with larger meshes than in the teeth in advance. Of only one tooth in this series is the ganoin of the crown preserved; parts of five other teeth of this row, however, remain *in situ*. The indications of a succeeding hinder row, *f*, of similar, but rather smaller teeth, are obvious; and the base of one tooth of a third, and probably hindmost row, *g*, is preserved.

In comparing the dentition of *Strophodus* with that of *Cestracion*, the chief difference is seen in the smaller number of rows anterior to the principal or largest: three rows, in each ramus, occupy the interval between such principal row and the mid-line of the symphysis; in *Cestracion* seven rows occupy that space in the upper jaw, and nine rows in the lower jaw; in this jaw, moreover, a medial azygous row occupies the mid-line of the symphysis, which is not the case in the upper jaw. (See Figure, inserted at page 236.)

According to this analogy, the teeth in the present specimen agree in arrangement with those of the upper jaw of *Cestracion*; but in the more gradual diminution of size, as they approach the symphysis, the teeth agree more with those of the lower jaw in *Cestracion*; the decrease being much more abrupt in the series next but one in advance of the principal series in the upper jaw of *Cestracion*. It is unlikely, from the minor number of rows and the larger relative size of the anterior teeth in *Strophodus*, that an azygous mesial row should be interposed at the symphysis of the lower jaw. But the elements for absolutely determining whether the present specimen be from the upper or lower jaw are wanting. I have assumed the latter for facility of description, partly from the gradual decrease forward in the size of the teeth, partly because a detached fossil jaw is so much more commonly a lower than an upper one.

But what is of more interest and importance is, that, in this long deferred acquisition of a specimen so much desired by Agassiz in 1836,[1] the main prevision so sagaciously deduced from fragmentary groups of the fossil teeth by the founder and chief builder of the fair edifice of Palichthyology is confirmed, viz.:—that "the genus *Strophodus* had a less considerable number of teeth in the jaw than the genus *Cestracion*:"[2] and the only emendation which this fossil suggests is, that "it does not appear, with regard to the rows in *Cestracion* homologous with those present in *Strophodus*, that there are fewer teeth in such rows in the fossil genus."[3] Of the teeth of *Strophodus* figured by Agassiz, those in Tab. 18, Vol. 3, op. cit., figs. 5 and 6, ascribed to *Str. subreticulatus*, and those figs. 12, 13, ascribed to *Str. magnus*, resemble teeth in rows *a* and *b* of the present specimen so closely as to indicate specific identity; perhaps the term *Strophodus medius* may conveniently indicate the species of the Caen Oolite, which includes more than one of the species originally proposed for detached teeth.

DESCRIPTION OF PLATE VII.

Fig. 1. Jaw of *Strophodus* from the Oolite of Caen (drawn of the natural size). The arrow indicates the line of symphysis and fore part of the jaw.

Fig. 1*a*. View of the section across the principal row of teeth, *a*, showing the curve of their attached bases. The figures and letters indicate the corresponding rows in the two rami of the jaw.

[A figure of the Jaw of recent *Cestracion* is given at page 236 of this Number.—Edit.]

II.—On the Supposed Influx of Water to the Interior of the Globe, as the Cause of Volcanic Eruptions.

By G. Poulett Scrope, Esq., F.R.S., F.G.S.

IT is now generally recognised that the power which forces up lava from a depth of miles through narrow and crooked fissures broken across the solid crust of the globe, is no other than steam, developed in the interior of the lava by vaporisation of water intimately disseminated throughout its substance. I am not aware that this view of the volcanic phenomena was put forward by any writer previously to the publication of my volume on Volcanos in 1825. But I had derived a conviction of its truth from observation of the great Vesuvian eruption of 1822, and a study of Etna and Stromboli in the years 1819-21. This was subsequently confirmed by the discoveries of Sorby, Scheerer, and others, of the existence of water in intimate molecular combination with the crystalline or granular minerals that compose the granitic rocks from the fusion of which lava is supposed to proceed. I had expressed my belief that the aqueous particles so confined, whether in a liquid or a solid state, would, upon the occurrence of increased heat, or diminished pressure, exert an elastic separating force upon the solid crystals or granules, in the manner of a flux, and thus assist the liquefaction of the mass, and drive it up any fissure that might open for its passage, in a pasty or semi-liquid state, short of complete fusion; so that on reaching the outer air, and parting with the contained steam, together with the heat which the expansion of this element would carry off in a latent form, its surface would consolidate instantly; and the solidification extending rapidly inwards by the formation of crevices giving an outlet to further vapour, the resulting rock would exhibit a cellular or porous structure, and a granular or crystalline texture, in lieu of the compact and glassy one which, if completely fused, it should possess.

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[1] "Alors il m'importait essentiellement de connaître leur disposition et leurs formes diverses."—Recherches sur les Poissons Fossiles, iii. p. 118.

[2] "Le genre *Strophodus* avait à ses mâchoires un nombre de rangées moins considerable que le genre *Cestracion*."—Tome. cit. p. 120.

[3] "Il me paraît également probable que chaque rangée contenait aussi moins de *dents placées les unes* derrière les autres, de dehors en dedans."—Tome. cit. p. 122.

These ideas were received at the time with incredulity. But their correctness is now not far from being generally recognised. For example, Professor Phillips, in his recent volume on Vesuvius, admits "the fact that water is present abundantly in the fluid lava," (p. 305), and again (p. 311), "steam pervades some parts—perhaps every part—of the fluid mass." He adds, "Lava cooled rapidly might *be expected* to be glassy in texture. This, however, is rarely, or never, the case in Vesuvius." It is strange that neither the Professor, nor other observers, should have sought for the cause of a fact so different from what was to be expected on the supposition of the complete fusion of the lava—yet so common, that, with the exception of the vitreous lavas of Lipari, Hawaii, Bourbon, and the trachytic obsidians and pearlstones, it may be declared to be universally true of all lavas, whether trachytic or doleritic.

But if we admit the existence of water, or steam, in close and intimate dissemination through every part of a mass of subterraneous lava, and of the rocks from whose liquefaction or semi-fusion by intense heat it proceeds, how are we to believe that this water could have found its way into this position from superficial seas or lakes, through fissures suddenly opened by the earthquakes which accompany an eruption? Such sudden influx of a body of water to a heated mass of mineral matter beneath, might be conceived to give rise to some equally sudden explosion at the point of contact; but the explosion itself, and the rise of lava up the fissure must, it is to be presumed, check any further penetration of water. The effect would be superficial only, and could scarcely so completely saturate the entire mass of heated rock, whether in a liquid or solid state at the time, as to cause its general ebullition, continued too through such lengthened periods as volcanic eruptions are often known to last.

Moreover, if we suppose an earthquake to cause the eruption of a volcano by suddenly admitting a body of water to its heated focus, what, it must be asked, causes the earthquake? Not certainly the influx of this same water through the rents which the earthquake itself only originates. The effect cannot produce the cause. Surely it is more reasonable to suppose that a local increase of heat transmitted from the sides or from beneath a volcanic focus, which had been for a time cooled down by the emission of steam and lava in earlier eruptions, gives occasion to the expansion of a body of subterranean mineral matter (whether *in a solid*, or fluid, or some intermediate condition, but already permeated with water), and by elevatory shocks produces the earthquake-rents, and, if any one of these communicate with the outer air, a volcanic eruption—the lava rising up the fissure to the surface, and the water in it flashing into steam wherever diminished pressure permits, especially in the upper part of the vent, from which the explosions always proceed. Nor is this view of the phenomena of eruption opposed to the general principles of the most eminent geologists, but the contrary. For example, Sir C. Lyell, in several passages of his Principles (see Ed. 1869, p. 233) represents the *original motive power* of both earthquakes and volcanos to be the lateral shifting of internal heat from one part of the subterranean matter to another; increase of heat occasioning expansion and elevatory movements accompanied by jarring rents causing earthquakes. If, then, we believe the internal heated matter already to contain water, which we know from examination does exist in all granitic and metamorphic rocks, the production of rents in this manner, giving partial freedom to the expansibility of the water, will account at once for earthquakes and volcanic eruptions, without supposing a flood of water from above suddenly to find its way down to and to penetrate every part of the interior of the heated rock in some unintelligible manner. Sir C. Lyell, indeed (Principles, Ed. 1869, p. 233), supposes the rents that have admitted this water may be suddenly closed above, and the water converted into steam below find its way somehow under a mass of fluid lava, which it may drive up some neighbouring volcanic vent. But he has himself shown in an earlier passage (p. 221) that it is only in the upper part of the column of lava in a volcanic vent that the "red-hot or white-hot water entangled in it, under tremendous pressure," is enabled by the reduction of that pressure to flash into steam, and produce the explosive phenomena of a volcanic eruption; and he fails to show—and does not even seem conscious of the necessity for explaining—*how* "atmospheric or sea-water suddenly descending from above" could become "so entangled" within and throughout every part of the lava.

I am aware that the theory I am opposing is considered to derive support from the very general occurrence of volcanic vents within or near to seas or large bodies of superficial water. But this same geographical position would result from the generally admitted fact that the continental tracts have been elevated above the sea-level by internal expansions of deeply-seated matter which could not force its way outwards; where, in the words of Mr. Mallet, "uncompleted efforts to establish a volcano" have occurred. Where the effervescent matter beneath has been enabled to find vent, there no elevation of the sea-bottom (to any great extent) will have taken place, but rather subsidence. And hence the great lines of volcanic eruption on the globe's surface are found within or in the immediate vicinity of areas of subsidence; in other words, of seas or great inland lakes. And further, if we suppose, as may well be conceded, that the elevatory action by which chains of mountains have been (probably through a succession of shocks) raised, is accompanied by the formation of more or less *distant downward* opening rents parallel to the axis of the elevated range, we shall find a cause for the general parallelism of the great lines of volcanic eruption to those of the nearest mountain chains or coast-lines of raised land,—a parallelism which has been often remarked, but unaccounted for that I am aware of upon any other hypothesis (see Volcanos, ed. 1862, p. 309).

One word more. If we are to suppose the water of lavas to have been derived through all past time from the superficial ocean, where are we to seek, it may be asked, the origin of the water of the ocean itself, if not from the interior of the globe, which even now sends out torrents of aqueous vapour from every rent opened through its crust? The believers in the nebular hypothesis will no doubt find it in the original gaseous atmosphere left after the condensation of the neuclus. But even conceding this for the bulk of the ocean, still it may well be supposed that large quantities of water remained "entangled" in the condensed matter.

Without, however, looking back to the beginning of things, as too many geologists are in the habit of doing, in order to explain phenomena of daily occurrence, I think I have shown reason for the belief that the water which evidently permeates the lava beneath a volcanic vent, and by its violent expansion occasions an eruption, existed there before the earthquakes that usually accompany the eruption began, and was not suddenly introduced by the opening of fissures communicating with seas or lakes above. Whether it existed in the material whence the lava is formed from the beginning, or proceeded from any chemical changes in this elementary rock, or magma—or had penetrated there by slow and long-continued filtration from above (which is the opinion of M.M. Daubrée and Fouquè), I do not hazard a conjecture. Our knowledge, at present, of the effects of intense heat and pressure, whether chemical or mechanical, on mineral substances—of the influence of terrestrial magnetism—and of the nature and origin of the deeply-seated matter that composes the globe, are too imperfect, I think, in the present state of science, to enable us to solve such problems. But since it has become the fashion, of late, among the leaders of popular geological treatises, to assume as a matter of fact, beyond dispute, that the substance of the globe, immediately beneath its thin superficial crust (and probably to its centre), is in a state of fluid fusion, and that the access of water from the sea above to this molten interior, is the exciting cause of earthquakes and volcanos, I have thought it well to express my reasons for entertaining doubts, to say the least, as to the correctness of either hypothesis.

FAIRLAWN, COBHAM, *April* 10, 1869.

III.—NOTES ON CONTINENTAL GEOLOGY AND PALÆONTOLOGY.

BY THOMAS DAVIDSON, F.R.S., F.G.S.

(*Continued from p.* 166).

(PART II.)

HAVING in my last communication presented the most recent views entertained by M. Coquand, I now proceed to mention those held by Monsieur Hébert, a most experienced observer, who

CLASSIFICATION OF THE UPPER CRETACEOUS PERIOD, by M. HÉBERT, March, 1869.

Formations or ges) stages.	STRATA (ASSISES).					
	Anglo-Parisian Basin.	Northern Europe.	Touraine & Maine.	Aquitaine.	Provence.	Pyrenees.
4. Upper Chalk.	2. Pisolitic limestone (Calcaire pisolilique).	Yellow chalk of Maestricht. Limestone of Faxœ and Limsteen.	Wanting.	Wanting.	Wanting.	
	1. Limestone with Baculites of Valogne (Calcaire à Baculites).	Grey chalk of Ciply. Limestone of Salthorm. Chalk of Ignaberga.				[3]
3. White Chalk.	4. b. Zone with *Belemnitella mucronata*, Mendon, Norwich.	Ciply-haldem, Hanover, Denmark, Western Scania, Rugen, Poland. Alps, Crimea.	Wanting.	Wanting.	Wanting.	E. Upper chalk with *Micraster Terrensis* of Tercis and of Tuco.
	a. Zone with *Bel. quadrata*, Remes.	Visé, Hanover, etc.			[2]	D. Clay with *Cyrena garumnica* of Auzas.
	3. Chalk with *Micraster Coranguinum*. Dieppe (West of), Gravesend.	Sands of Aix-la-Chapelle, Quadersandstein at Gehrden (Hanover) at neighbourhood of Cracovie.	Chalk of Blois.	[1] Chalk of Royan and of Ambeterre.	Lignites of the Plan d'Aups and of Beausset.	C. Limestone with *Hemipneustes Pyrenaicus* of Ausseing, of Gensac, and of St. Sever.
	2. Chalk with *Mic. Cortestudinarium*, Dieppe (east of).	Zone with *Inoceramus Cuvieri* of Strombeck. Wollin Island, Opelm (Silesia).	Chalk of Chateaudun.	Chalk of Saintes and of Talmont.		B. Limestone and marls of Bidart and of Lower Tercès.
	1. Chalk with *Holaster planus*, Dieppe (east). Chalk rock of England.	Zone with *Scaphites Geinitzii* of Hanover, Saxe, of Silesia (Opelm), etc.	Chalk of Villedien. Zone with *Mic. brevis* and *Ostrea Matheroniana*.	Chalk of Cognac. Zone with *Mic. brevis* and *Ostrea matheroniana*.	Upper chalk of the Martigues with *Ostrea matheroniana*.	A. Sandstone of Celles.
2. *Chalk* of Touraine and Limestones with *Hippurites*.	2. Wanting.	Wanting, but is found again in Bavaria, in Bohemia, etc., with the aspect of the Touraine.	Tuffean (chalk) with *Ostrea Columba*, var., *Gigas*.	Limestone with *Hippurites cornuvaccinum*.		
			Tuffean (chalk) with *Ammon. peramplus*.	Limestone with *Radiolites cornupastoris*.	Sandstones of Uchaux. Limestone with *Rad. cornupastoris*.	Wanting.
	1. Chalk with *Inoceramus*	Westphalia (Œhaus). Hanover, zone				

			Anorthopygus orbicularis.			
1. Craie Glauconieuse (chalk with chlorite grains).	1. c. Zone with *Holaster subglobosus.* b. Zone with *Hol. subcarinatus.* a. Zone with *Hol. suborbicularis.*	Westphalia and Hanover, etc.	Beds with *Orbitolites concava* of Ballon.	Sandstone with *Orbitolites* of Rochefort. Lignites of Touras and the Island of Aix.	Marls, limestone, and sandstones, with *Ammon. varians* and *Orbitolites concava* of Cassis and Escragnolles, etc.	Wanting.

LOWER CRETACEOUS PERIOD.

3. GAULT.[4] Wanting. Wanting.

			Basin of Paris.	Southern France, Switzerland, etc.
2. NEOCOMIEN FORMATION.	Sub-formation (sous étage) *Aptien*, d'Orbigny.		Clay with Plicatulæ and with *Ostrea aquila* (argiles à Plicatules).	Aptien marls.—1st stage of M. d'Archiac: Sandstones with *Ostrea aquila* of the Perte-du-Rhône (Upper Aptien of Pictet and Campiche, provisional table of 1858). Limestone with *Ostrea aquila* of the Pyrenees.
	Middle Sub-division. *Urgonien*, d'Orbigny.	Upper stage.	Red bed of Vassy.	Limestones and marls with *Orbitolites*. *Rhodanien* stage of Renevier. Lower Aptien of Pictet and Campiche. Lignites of Utrillas (Spain).
		Lower stage.	Freshwater sandstone, Sands and marbled clays.	Limestones with *Dicérates* of Elie de Beaumont and Dufrenoy. Limestone with *Chama* (*Caprotina ammonia*). *Urgonien* stage of Renevier, Pictet, etc.
	Lower Sub-division.	Upper stage.	Oyster clays (argiles ostréennes.	Limestone with *Scaphites yvanii* of Barrême, etc.
		Middle stage.	Limestone with *Spatangus*.	Limestone with *Spatangus*. Limestones and clays with *Belemnites dilatatus*, etc. *Valanginian* stage of Desor.
		Lower stage.	Marls and sands.	Limestone with *Ammonites macilentus*. *Diphya kalk* of the Porte-de-France, of the Tyrol, the Carpathes, etc.

1. WEALDEN STAGE.

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[1] I consider hitherto the *Dordonien*, *Campanien*, and *Santonien* of M. Coquand as inferior or lower than the chalk with *Belemnitella mucronata* of the North, for the reasons specified in the Bull. Soc. Geol. of France, 2nd ser. vol. xx. p. 90, and vol. xix, p. 542.

[2] I do not mention the limestones with *Lychnus*, which, perhaps, represent all or part of the upper beds of the Chalk; my opinion is not yet fixed.

[3] I am still at a loss to know how we ought to correlate the stages A, B, C, D, E, with the chalk of the North.

[4] Hitherto I cannot perceive sufficient reasons for detaching the Gault from the Lower Cretaceous Period.

has made the "Cretaceous system" a subject of particular study. M. Hébert considers that M. Coquand has separated the period into too many definite divisions (étages), and in two papers published in the *Bulletin* of the Geological Society of France (vol. 16 and 20, 2nd series), his views upon that topic have been fully recorded. He had not, however, drawn up any complete scheme of classification, but this he has now kindly done at my request. (See Table of Classification.)

The same gentleman justly insists that it is impossible to ascertain the absolute value of the divisions by the characters which they may exhibit in a single region; that the Chalk with Belemnites so sparingly represented throughout Western Europe, would appear on the contrary to cover in the East immense surfaces, and the Upper Chalk, though reduced to a few spots throughout the whole of Europe, assumes in America and India a considerable extension.

Monsieur Cornuel has likewise devoted considerable attention to the divisions of the Cretaceous system, and has kindly furnished me with the following statement, with reference to various classifications applied to the same group by himself, and Messrs. Leymerie, d'Archiac, Renevier, and Hébert. He still adheres, however, to the classification proposed by himself in 1860, and does not approve of the alterations introduced by M. Hébert in his paper published in the twenty-fourth volume, p. 379, Feb. 1867, of the Bulletin of the Geological Society of France.

DIVISION OF THE LOWER CRETACEOUS FORMATION IN THE DEPARTMENT OF THE HAUTE-MARNE, BY M. CORNUEL. (Bulletin of the Geol. Society of France, 2nd Series, vol. xvii., p. 742. 1860).

				16. Gault.	
				15. Green sand.	
				14. Sand and yellowish sandstone.	
LOWER GREEN SAND.	2nd Stage or Aptien.		2nd bed.	13. Clay with *Plicatulæ* (argiles à Plicatules).	upper. middle.
			1st bed.	. . . .	lower (*Brachiopoda*).
				12. Red bed.	
	1st Stage or Neocomien.	Sub-division Upper Neocomien (Urgonien).	2nd bed.	11. Oolitic iron. 10. Sand and upper ferruginous sandstone. 9. Rose-coloured variegated clay. 8. Spotted sands and sandstone.	
			1st bed.	7. Clays with oysters (argiles ostréenne)	upper. lower.
		Sub-division Lower Neocomien.	2nd bed.	6. Yellow argillaceous marl. 5. Limestone with *Spatangus* Blue calcareous marls	(*Brachiopoda*).
			1st bed.	4. White Sand. 3. Sand and lower ferruginous sandstone. 2. Iron in rounded masses (Fer Géodique). 1. Blackish argillaceous marl (*Brachiopoda*).	

Each of these beds have been described by M. Cornuel in the Mémoirs of the Geol. Soc. of France (1 series, vol. iv., p. 230), but the references to the fossils are not correct, and have been replaced by others in the 8th vol., 2nd series of the Bulletin of the same Society (p. 430). M. Cornuel has added to his paper published in 1860, a notice on the connections existing between the country of Bray and the Isle of Wight (Bull. 2 series, vol. xix., p. 975); and, *in another* communication, he assigns the limits of the two stages and their connection with the Mediterranean Basin (Bull. 2 series, vol. xx., p. 575), and finally one on the insufficiency of the *Ostrea aquila* as a medium to define the limits of a zone (Bull. 2 series, vol. xxi., p. 351). In the fourth vol., 1 series, p. 291 of the Mémoirs of the Geological Society of France, M. Leymerie classes the Lower Cretaceous formation of the Department of the Aube in the following manner:—

NUMBERS CORRESPONDING TO THE SAME BEDS IN THE DEPARTMENT OF THE HAUT-MARNE AS GIVEN BY M. CORNUEL, IN HIS SECTION.

Stage of the clays with Tegulines and Green sand. (Stage des argiles téguliness et du grès vert).	Upper portion.	13 middle, & upper 14, 15, 16.
	Lower portion.	13 lower division.
Neocomien stage.	Upper stage.	8, 9, 10, 11, and 12, (those having been seen in the Dept. of Aube, in kidney-shaped masses only).
	Middle stage.	7.
	Lower stage.	1, 2, 3, 4, and 5.

In his history of the progress of Geology, vol. iv. p. 278, Vicomte d'Archiac suggests the following distribution :—

Neocomien Group, or of the Lower Green Sand.	Upper stage.	Upper beds No. 14, 15. Lower bed 13.
	Middle stage.	Upper beds 8, 9, 10, 11, 12 ? Lower bed 7.
	Lower stage.	Upper beds 5 and 6. Lower beds 1, 2, 3, 4.

M. Renevier thinks that the relations with the Perte-du-Rhône are as follows (Bull. Soc. Geol. France, 2nd. series, vol. xii., p. 89, and vol. xi., p. 114).

Gault	No. 15-16.
Aptien	„ 13, 14.
Rhodanien..	„ 12.
Urgonien	„ 10, 11.
	(8 and 9 are left without reference to what precedes or follows).
Stage of Hauterive or Middle Neocomien	5, 6, 7.
	(3 and 4 are left without reference to what precedes or follows).
Valangien or Lower Neocomien	1 and 2.

Lastly, in vol. xxiv., p. 379, 1867, of the Bulletin Soc. Geol. France, M. Hebert establishes the correlations between the series of the Haute-Marne and Southern France, Switzerland and Spain, and for which he proposes the following scheme, but from which he, M. Cornuel, dissents :—

Neocomien.	Upper sub-stage (Aptien of d'Orbigny),		No. 13 of the Haute-Marne.
	Middle sub-stage, (Urgonien d'Orb.),	upper beds,	„ 12, „ „
		lower beds,	„ 8, 9, 10, 11 „
	Lower sub-stage,	upper bed,	„ 17, „ „
		middle bed,	„ 5, 6, „ „
		lower bed,	„ 1, 2, 3, and 4 „

These different schemes and the corresponding numbers furnished to me by M. Cornuel, at once show the views entertained by the above-named geologists at the period of their various communications.

Nevertheless, in a letter I recently received from M. Leymerie, of Toulouse, I am informed that the Cretaceous system in the Departments of the Aube and Yonne can be divided into—1. Neocomien; 2. Aptien; 3. Gault; 4. Lower Chalk; 5. Middle Chalk; and 6. Upper Chalk; and that he does not consider so complicated a division of the system as that proposed by M. Coquand will be found necessary, when the great or general characters of the period have been generally considered. He likewise reiterates the opinion already expressed by M. Coquand and others, namely, that it is not possible to maintain the Aptien and Urgonien as distinct stages, since they have been found to alternate. He divides the Cretaceous formations in the Pyrenees into *Urgo-aptien*, *Sénonien*, and *Garumnien*, and will shortly publish, along with his detailed geological map of that portion of France, a complete description of the different divisions into which he has considered it desirable to map out the system.[1]

In the Bulletin de la Sociéte Vaudois des Sciences Naturelles, vol. ix., p. 204, 1867, M. E. Renevier proposes the following scheme of classification, and on my recent visit to Lausanne, I requested him to add some further details, and a correlation with the same formations in England, which I now reproduce.

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[1] Mr. Tombeck, Professor of Geology at the Lycée Bonaparte in Paris, has also devoted considerable attention to the Cretaceous formation, as displayed in the department of the Haute-Marne, and he has favoured me with the following notes. "My table differs from that published by M. Cornuel merely in some unimportant details."

Albien.	1. Clays of the Gault.
	2. Green Sands.
Aptien.	3. White Sands.
	4. Clays with *Plicatulæ* (argiles à Plicatules), upper.
	5. „ „ middle.
	6. „ „ lower.
Urgonien.	7. Red bed.
	8. Oolitic iron.
	9. Dotted sandstone and marbled rose-coloured clay.
Neocomien.	10. Clay, with oysters, (argiles ostréenne).
	11. Yellow clayey marl.
	12. Limestone with *Spatangus* (Calcaire à Spatangues).
	13. Blue marl.
Valangien.	14. White Sands.
	15. Ferruginous Sands.
	16. Géodique ore.
	17, Blackish clayey marl.

"The beds in which I have met with Brachiopoda are 5, 6, 11, 12, 13, 16, and 17, but they are very unequally distributed. In the bed 6, I found *Tereb. sella*, *Terebratella astieriana*, *Rhy. lata*, *Rhy. depressa*, and a small Terebratula, that might be a young *Ter. faba*. The bed No. 11 has produced *Terb. oblongus* only; while the beds 12 and 13, which contain the same fauna have furnished, *Terebratula sella*, *T. prælonga*, *T. tamarindus*, *T. pseudo-jurensis*, *T. faba* (2 varieties), *T. semistriata*, *T. Moutoniana*, *T. collinaria*, *Terebratella oblonga*, *T. reticulata*, *T. neocomiensis*, *Rhynchonella depressa*, *Rh. lata*, *Rh. Renauxiana (?)*, and 4 other species of *Rhynchonella*, *Thecidea tetragona*, and a species of *Argiope*. The beds 16 and 17 contain only *T. sella*. Now, although I have made use of the specific names adopted by d'Orbigny to the *Rh. depressa* and *Rh. lata* that occur in beds 6, 12, and 13, I am persuaded that those from No. 6 are completely distinct, not only as varieties, but also specifically from those that occur in beds 12 and 13, and the same may be stated with reference to the *T. prælonga*, said *to occur in beds 12 and 13.*

Subdivisions of the Cretaceous System. (By M. E. Renevier.)

Super-Cretaceous Group or Sénonien.	**Danien = Upper Chalk of Maestricht: Limestone with *Baculites*: (Pisolitic Limestone; occurs neither in Switzerland nor England).**
	Sénonien = White Chalk: Chalk with flints: Chalk of Meudon: Upper Chalk, Norwich, Gravesend, Woolwich, in England; Seewerkalk, in Switzerland.
	Santonien = Lower Sénonien, Chalk of Villedieu, (peculiar to France, and does not occur either in Switzerland or Great Britain).
Méso-Cretaceous or Cénomanien.	**Turonien = Craie tuffeau; Chalk with *Inoceramus mytiloides*. (Upper portion of Lower Chalk of Beachy Head in England, does not occur in Switzerland).**
	Carentonien = Upper portion of the Green Sands of the Sarthe; (zone with *Ostrea biauriculata* does not occur either in England or Switzerland).
	Rotomagien = Craie Marneuse; Chalk of Rouen: Lower part of *Lower Chalk* Ventnor: Chlor. Marl England. Cheville and St. Croix in Switzerland.
	Vraconnien=Upper Green Sand: zone with *Pecten asper*: Upper Gault in Switzerland, Cheville, St. Croix, Perte du Rhone: Warminster and Cambridge in England.
	Albien = Gault. Middle and Lower Gault in Switzerland (Cheville, Perte du Rhône, St. Croix, etc.). Folkestone, Wellant, etc.
Infer-Cretaceous or Neocomien.	**Aptien = Clay with *Plicatula*: Upper Aptien: Hard Sandstone of the Perte du Rhône: upper portion of Lower Green Sand of England.**
	Rhodanien = Lower Aptien, Yellow Marls of the Perte du Rhône, red bed of Vassy; lower portion of Lower Green Sand of England, Perna bed of the Crackers of *Dic. Lonsdalii*.
	Urgonien = Upper Neocomieu: White Limestone with *Req. Ammonia*, 1: Zone of Rudistes: Yellow Limestone of Maurmont, Russille.
	Neocomien = Middle Neocomien; Marles of Hauterive: Limestone with *Spatangus*: Yellow Limestone of Neuchatel: Mortean Marle of Hauterive: Yellow Marle of *Am. Astierianus*.
	Valangien = Lower Neocomien: zone with *Pygurus rostratus*: Limestone of Berrias?

In a paper, by the same author, published in the Bulletin of the Societe Vaudoise of Natural History, vol. v. p. 51, it is stated that the *Lower Green Sand* does not equal (as the larger number of geologists have supposed) the Neocomien, but would exactly correspond to the *Aptien* beds, which he (M. Renevier), recognised between the Upper Neocomien (Urgonien) and the Gault. That the lower beds of the Lower Green Sand (Perna beds and Crackers of the Isle of Wight) contain a fauna which is analogous to that of the Lower Aptien (Rhodanien) of the Perte-du-Rhône, while the arenaceous bed of about 650 English feet, situated between *The Crackers* and the Gault, belongs without doubt, to the Aptien; and in concluding his memoir on the "Faune de Cheville," M. Renevier hesitates to admit as large a number of divisions in the Cretaceous system as have been proposed by M. Coquand, but at the same time he considers that each fauna, of which the larger number of species are peculiar to it, and not offering a mere local aspect, but occupying a rather general stratigraphical horizon, should constitute an independent division. He in consequence willingly admits all the divisions recently introduced partaking of those conditions, and all those of which the Palæontological monographs will in future demonstrate their utility.

(*To be continued*).

IV.—ON THE DISCOVERY OF A SKELETON OF THE HIPPOPOTAMUS IN POST-PLIOCENE DRIFT NEAR MOTCOMB, DORSET.

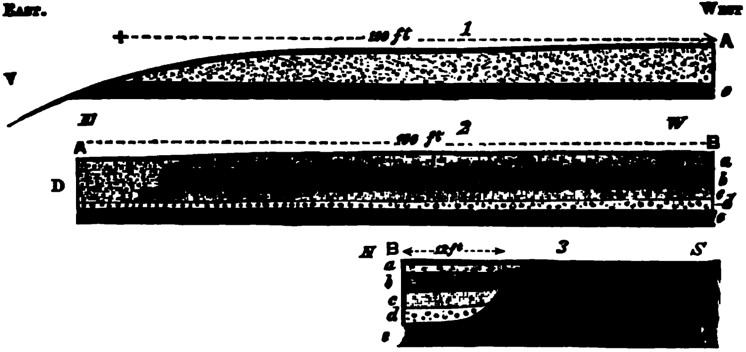
By T. THOMPSON, Esq.

THE existence of Post-pliocene deposits in this neighbourhood has until lately been quite unknown, nothing of the kind having been detected either by the Geological Survey or subsequent observers. However, in the winter of 1866, a small section was exposed in a brick-field situated on a low rising-ground at the first milestone out of Shaftesbury towards Gillingham, and known as Hawkers' Hill. The clay here dug for brickmaking is Kimmeridge, presenting fossilized bones of the *Pliosaurus* and *Icthyosaurus*, and very friable remains of an Ammonite, etc. The attention of the writer was first attracted to the Drift on observing, above part of the Kimmeridge clay, a thin section of soil of an ochreous tint due to oxide of iron, and somewhat resembling the loose stratum of chert and sand which caps the neighbouring Green-sand rock. He learnt on inquiring of the labourers that they had recently found some large bones in this deposit, but thinking them of no use they had wheeled them off with the rubbish, in which they then lay, effectually re-buried. Much interested at this announcement, he induced the men again to remove the rubbish, and found that the bones were some vertebræ of a large mammalian animal, together with fragments of the ribs and leg-bones. They were, of course, not at all fossilized, and their original weak state had been sadly aggravated by a second burial and disinterment. Nothing more was turned out that winter, and it was not until the end of 1867, that digging was resumed. Further portions of the same skeleton were now found, including another instalment of vertebræ, and portions of the skull and jaws. With the latter were several teeth in a sufficiently entire state to show that the creature was undoubtedly a Hippopotamus; numerous fragments of the tusks affording further proof of this. The writer now frequently visited and watched "the diggings," and after a short time two horn-cores, considerable portions of the skull, and some fragments of the leg-bones of *Bison priscus* of unusual size came to light. The more perfect horn-core is 18 inches long and 14 inches in diameter at the base.

The past winter brought the usual resumption of clay-digging, and the necessary removal of more of the superincumbent Drift. The upper portion of the skull and two horn-cores of another *Bison priscus* were first reached, and as they lay in their natural position the distance between the tips of the horns was upwards of four feet. Notwithstanding that the writer took great precautions in the hope to preserve this highly interesting relic in an entire state, he had the mortification to see it crumble into fragments in the process of removal, and could only succeed in patching up a portion of one of the horn-cores. As the digging went on, a molar of an elephant—probably *Elephas primigenius*—and parts of one or more tusks were turned out, but all in a sadly fragmentary state. The piece of tusk appears to have been nearly 6 feet long, but the whole was completely disintegrated with the exception of the central portions. The excavations of this winter were closed with the discovery of bones representing most of the remaining portions of the Hippopotamus skeleton. We are thus led to the interesting inference that this huge animal must have lived and died near to the spot where its remains were found, since they must have been laid in their sandy grave before decomposition had set in.

As regards the condition in which these interesting Drift-remains were found, it may be remarked that the soil seems to have been very unfavourable to their preservation, large portions of the bone being so completely decayed as to be distinguishable by colour alone from the surrounding sand, while often the articulated terminations only would bear removal. None of the bones presented marks of gnawing or were water-worn.

SECTION OF DRIFT AT HAWKER'S HILL.



Section 1 unites with Section 2, at the point marked A. in each, and forms one continuous line East and West.

3. Cross-section (North and South) of Drift, as far as excavated, showing the termination of the Deposit against a bank of Kimmeridge Clay. The thick black line on the top of section is the surface-soil.

(V.) Valley towards Shaftesbury. The Drift commences in Section 1, and rests on the Kimmeridge Clay (*e*).

a. Thin bed of sand stained with Oxide of Iron, with fragments of Chert not rounded.

b. Green Sand and Blue Clay, with a few angular stones; 3 feet in thickness.

c. Green Sand almost pure and free from stones; 3 feet thick.

d. Sub-rounded stones imbedded in Blue Clay and silt; 2–3 feet.

e. Kimmeridge Clay.

Respecting the nature of the Postpliocene deposit (see Woodcut), the greatest thickness of the portion hitherto excavated is only about 10 feet. Beneath the sod of the field is, first, a thin bed of sand (*a*), stained with oxide of iron, and containing fragments of chert, etc., not rounded. Next follow (*b*), 3 feet of Green sand and Blue clay, with a few angular stones, and succeeded by about the same thickness of Green sand (*c*), almost pure and free from stones. The base of this deposit (*d*), is a 2 to 3 feet bed of sub-rounded stones—the largest, perhaps, equal to a double fist—imbedded in blue clay and silt, which had evidently formed the bottom of a river for a lengthened period. Its compact nature is evidenced by the belief of the labourers that it was an old road. Nearly all the bones were found either resting on, or imbedded in this stratum, with the exception of the skull and horn-cores of *Bison priscus* in 1867. It will be observed that the upper layers of the Drift are totally distinct in character from this, being such as might be attributed to the rapid action of a series of floods sufficiently violent to silt up the Post-pliocene river-bed. The component materials are almost exclusively derived from the adjoining Green Sandstone formation; the only exception being that the Blue clay mentioned as occupying a middle position appears to be the surrounding Kimmeridge clay altered by water action. The deposit is on the side of Hawkers' Hill, towards the far higher elevation of Green Sandstone and Gault on which Shaftesbury stands. The portion hitherto dug out is nearly 200 feet long, consisting, at its commencement on the hill side, of the old river bed, but slightly marked at first, with perhaps one foot of the loose sandy strata above it. Partly by the rise of the hill and partly by a slight dip of the river-bed in the contrary direction, the final thickness is increased to about 10 feet. The width excavated is only some 12 feet. We are here evidently at one margin of the Post-pliocene river, the Drift coming to an end against an abrupt bank of undisturbed Kimmeridge clay 10 feet high (see Section 3).

The surface of the hill is perfectly uniform, looking as exclusively *Kimmeridgian* as the seven or eight miles of that formation which stretch from it westward across the low lands. It will be understood that Shaftesbury hill is a high eminence composed of Upper Green Sandstone resting on Gault, and is separated from Hawker's Hill by a valley of gentle declivity. The Gault crops out some 500 yards from the Drift, and is succeeded on the steep hillside by Green Sandstone, like that from which the materials for the latter were derived. As regards the general configuration of the country, it seems hopeless to conjecture how the river could ever have flowed where its indelible traces still remain. Under present circumstances, it would be a physical impossibility. Nor is there any existing river in any direction for some miles. It should be added that most anxious search was made for any shells that might aid in determining the climate probably prevailing when the Drift was deposited, but the only acquisition was one battered and flattened snail shell—either *Helix arbustorum* or *nemoralis*. No flint implements or human relics of any kind have been found in this deposit.

The writer is indebted to Dr. Blackmore, of Salisbury, for his kindness in making a careful examination of the remains discovered, and is permitted to quote his valuable authority for the correctness of the names assigned them. It is Dr. B.'s opinion that there are indications of at least three individuals of *Bison priscus*.

The writer will be happy to answer to the best of his ability any communications that may be addressed to him on this subject.

GILLINGHAM, DORSET.

V.—THE DISCOVERY OF DIAMONDS AT THE CAPE OF GOOD HOPE.

By W. GUYBON ATHERSTONE, M.D., F.G.S., of Graham's Town, Cape of Good Hope.

IN the GEOLOGICAL MAGAZINE of December, 1868, appears an article on this subject by Mr. J. R. Gregory, declaring the whole story of the Cape diamond discovery to be "false," "an imposture," "a bubble scheme," got up to promote the expenditure of capital in in searching for this precious substance in the colony; and stating that, from the geological character of the district which he had lately very carefully and thoroughly examined, it was *impossible* that diamonds had been or could ever be found there.

As it was mainly through me that this accidental discovery was brought to light, and as I am therefore by implication accused of being one of the impostors in this fraudulent "bubble scheme," I trust I shall be allowed to make a few remarks in refutation of so extraordinary and unfounded a charge.

To enable your readers to judge of the truth and correctness of Mr. Gregory's statements and conclusions, I will give a brief history of the diamond discovery so far as I am concerned; and I forward to Professor Tennant, of King's College, by this mail, the first three original letters received by me, which may be examined by Mr. Gregory, Mr. Emmanuel, or any other person interested in this matter. In March, 1867, I received through the Post-office from Colesberg, a letter from Mr. Lorenzo Boyes, Clerk of the Peace for that district, of which the following is a verbatim copy:—

> COLESBERG, March 12, 1867.
>
> MY DEAR SIR,—I enclose a stone which has been handed to me by Mr. John O'Reilly as having been picked up on a farm in the Hope Town district, and as he thinks it is of some value I send the same to you to examine, which you must please return to me.—Yours very sincerely, L. BOYES.

In the envelope with this note was diamond No. 1 quite loose, the letter not *registered* nor sealed, simply fastened by gum as usual. I had never seen a rough diamond before, but upon taking its sp. gr. and hardness, examining it by polarized light, etc., I at once decided that it was indeed a genuine diamond of considerable value; and perceiving the great importance of such a discovery to the colony, I at once wrote to the Hon. Richard Southey, Colonial Secretary, announcing the fact, and suggesting that it should be sent to the Paris Exhibition, and afterwards sold for the benefit of the finder. On receipt of my letter in Cape Town, the Colonial Secretary at once telegraphed to me to send it up to Cape Town and he would send it to the Crown agents for transmission to the Paris Exhibition. I gave it to Sir Percy Douglas, our Lieutenant-Governor, who kindly had it conveyed by the next steamer to Cape Town, where it was examined by the French Consul, M. Herriette, and other competent judges, who confirmed my opinion; it was afterwards sent to the Paris Exhibition. and purchased by the Governor of the Colony, Sir Philip Woodhouse, for £500.

Now if there be any fraud or imposture with the Cape diamonds, it must be with the discovery of this, the first and most valuable diamond, and I will therefore go rather more minutely into particulars as to the parties connected with it. It was by mere accident that a Dutch farmer named Schalk van Niekerk, seeing some children of a Mr. Jacob, another Boer, playing with some bright stones, noticed this one in particular, and asked the mother to sell it to him.

She laughed at the idea, and gave it to him at once. Mr. John O'Reilly (son of the late Civil Commissioner of Somerset, and grandson to Colonel O'Reilly, now in Graham's Town,) happened to be returning from a hunting and trading expedition in the interior, and Mr. Niekerk asked him to find out what sort of a stone it was. Mr. O'Reilly took it to Colesberg and showed it to his friend Mr. L. Boyes, the Clerk of the Peace (son of Captain Boyes, an officer in H.M. service), who sent it to me. The parties concerned, therefore, were—a farmer's child, a Dutch Boer, Mr. O'Reilly, Mr. L. Boyes, a Government official, myself, and Sir Philip Woodhouse, Governor of the colony, who purchased it. Which of these parties is the fraudulent impostor, getting up a land-jobbing speculation? since this is one of the reasons assigned for the supposed planting of diamonds in the colony. Mr. Gregory's theory regarding the expenditure of capital in search for diamonds, carries its own contradiction with it. None of them own land in that part of the country except Mr. Niekerk and Mr. O'Reilly, and the gem was not found on Mr. O'Reilly's or Mr. Niekerk's farm, nor were either of their farms for sale at the time. Is it reasonable to suppose that if either Mr. Niekerk, or Mr. O'Reilly, or Mr. Boyes, had imagined it to be a gem of the value of £500, it would have been trusted to the letter-bag through the Post-office? The idea is simply *absurd*; and the fact that twenty other diamonds have been discovered since, at spots far apart, on Government ground, in the territories of native chiefs, along the Orange River, Vaal River, and Reit River, and far beyond the colony, where there is no land to sell,—and found by all kinds of persons, Englishmen, Boers, Griquas, Bechuannas, Hottentots, and other natives, who can have no possible connection with land speculation, proves the utter absurdity and impossibility of those statements.

Of the diamonds already found, six were discovered along the Orange River, in the Hopetown division; six along the Vaal River, three beyond the Vaal River, two beyond the Orange River, two along the Reit River, and one in Waterboer's country, and one on Government land in the colony. Again, who have been the purchasers? Five have been sold to the Governor; two to Mr. Hond, the lapidary; three to Mr. Lilienfeld; one to Mr. Chapman, of Cape Town; one to Mr. M. Joseph, of Cape Town; one to Mr. Cruikshank, to send to Scotland,—*none of these* in any way connected with land speculations.

It is a fact that there have been no land speculations or sales in that neighbourhood since the diamond discovery was made known. I think this mass of evidence must quite overthrow Messrs. Gregory and Emmanuel's theory that diamonds were placed there *for a purpose*, and satisfy every unprejudiced person that the discovery is a *bonâ fide* discovery, and one of immense importance to the colony.

Now as to Mr. Gregory's geological facts. He states, "The whole of the district from Cradock, almost in a direct line to Hopetown, upwards of 250 miles, is composed of igneous or volcanic rocks; the huge piles of rounded boulders are Trap porphyries, and the Trap dykes in many places have forced them up, and the sands both of a white and red colour, are simply the *debris* from the breaking up and wearing away of their burnt porphyries and burnt clays or Porcellanite, which were formed originally through the volcanic heat vitrifying these silicious clays. No other geological deposits are visible, nothing but igneous and volcanic rocks, and the sands mainly produced by their decomposition, and associated with these sands and in the beds of the Orange and Vaal rivers are the characteristic Trap minerals only—such as Zeolites, Natrolite, and sometimes Stilbite, with small agates and geodes of chalcedony; from the interior of which geodes, but of larger dimensions, are derived the brilliant rock crystals, of which thousands may be found, most of them rounded on the edges, though some are perfectly uninjured, as the usual hexagonal prism, sometimes with both terminal pyramids." Now I am fortunately able personally to contradict this statement *in toto*, for although I have not visited the Hopetown District, I have examined the Cradock district, and the country between it and Colesberg, and I have myself collected beautifully perfect reptilian and other *fossils* from the very parts which Mr. Gregory declares to be nothing but igneous and volcanic. "No other geological deposits are visible," he states! Dr. Gray, of Cradock, has sent home numbers of *Dicynodon* and other fossils from this very district; so have I and Mr. Bain, Mr. Stowe, and others. If this is a specimen of Mr. Gregory's careful and lengthened examination of the Cradock division, we know what value to attach to his report and examination of the Hopetown and diamond-yielding district!

Mr. A. Wyley, the colonial geologist, gave ten *years ago, and before diamonds were thought of as existing there*, a careful geological description of the Hopetown district, which Mr. Gregory may consult with advantage. He will find a copy of this report in the Geological Society's Library, which I sent through Professor Rupert Jones. It is entitled "Notes of a Journey in two directions across the colony made in 1857-8," by A. Wyley, Esq., Geological Surveyor to the colony, 1859. He describes the country as consisting of *Sandstones*, *Shales*, and *Schists*, intersected by basaltic trap-dykes, etc.; in fact very similar to the great basaltic plateaus and horizontal Sandstone formations in India, where the most celebrated diamond formations occur, and to which I think it will be found our diamond-bearing formations bear a strong resemblance. Mr. Gregory, in describing the conglomerate in which the Hopetown diamonds are found, insists on what he terms "an *important* distinction," as being not a silicious conglomerate, as those from Brazil, but as being sometimes formed into a solid conglomerate by the aid of lime. But why should our diamond conglomerates be necessarily like those of Brazil? Why not rather like those of India, to which, as I have stated, our rock formations, our vast horizontal sandstones, capped and permeated by basalt, and in many cases our fossils also, bear so striking a resemblance. In Malcolmson's paper on "The Great Basaltic District of India, and the Diamond Sandstones and Argillaceous Limestones," published in the Geological Transactions, 2nd series, vol. v., he says, describing the celebrated diamond mines of Banquapilly, page 541, "the plains at the base of the table-land of Banquapilly consist of a rich black alluvium, containing fragments of basalt, jasper, and various minerals found in the hills, the rocks are a fine, compact, dark blue or marly black *limestone*, which contains much argillaceous and silicious matter."—"On ascending the hill, the limestone becomes more schistose, and is of a paler colour," etc. "Above Banquapilly it contains the diamond-breccia described by Voysey," etc., etc. Now, if Mr. Gregory will carefully read Dr. John Shaw's account of the site of the diamonds and the conglomerate bed in which they are found, published in the *Graham's Town Journal* of Jan. 20, 1869, he will find it exactly resembles the diamond-breccia and conglomerate found in India.

From the great distance of the finding places apart, and their propinquity to the several river beds, which all proceed from the Quathlamba or "Draken's berg" sandstone ranges, I have little doubt that, on careful exploration, the real source of the diamond deposits will be found far to the eastward. Sufficient has been already discovered to justify a thorough and extensive geological research into this most interesting country; and I think, for the interest of science and the benefit of this colony, a scientific examination of the country will be undertaken. So far from the geological character of the country making it *impossible*, I maintain that it renders it probable that *very* extensive and rich diamond deposits will be discovered on proper investigation. This, I trust, the Home Government will authorize, as our colonial exchequer is too poor to admit of it. Mr. Gregory in his paper (see GEOL. MAG., No. 54, p. 559) honestly states his pre-conceived ideas of the falsity of the diamond discovery: "I had an idea of this" (*i.e.* that the whole story was false) "when I first reached George Town, then at Port Elizabeth, Graham's Town, Cradock, Colesberg, and finally on arriving at Hopetown, where no further proof of diamonds could be obtained." And I fear we may add to this list of places—where he held these views, *London* also!

Mr. Gregory called upon me, hearing that I had the Pniel diamond (No. 7 of Mr. Chalmers' list, which appeared in the *Journal of the Society of Arts*, Feb. 13th, 1869); but, unfortunately, he did not call until after the post had left, although he arrived in Graham's Town before, and I had already sent it off to the Colonial Secretary. However, I showed him a photograph and plaster cast which I had taken of it, *from which* he at once pronounced an opinion as to its *quality*, declaring it to be a "boart" diamond of very little value!! In his paper referred to, he says "This stone (No. 7) was stated to have been picked up by a Griqua on the banks of the Vaal River, near Pniel. I afterwards found this was not true, and it was said to be really found near Campbell, 100 miles from Pneil, and by a Griqua who has since found two or three others. So the locality at Pniel is a myth." Now here Mr. Gregory is evidently confusing two different diamonds: see Nos. 7 and 8 in Mr. Chalmers' list. The missionary, Mr. Radeloff, was my authority for saying it was *found near* Pniel, and Mr. Chalmers I see corroborates this state-

ment. Mr. Gregory told me his object was not to search for diamonds, but for nickel and other minerals usually found associated with them, and that he intended visiting the Namaqua land mines before he returned. His motives and objects, and those of his friend the diamond merchant, Mr. Emmanuel, are now but too apparent. Why all this attempt at mystification, unless he had a purpose to serve?

VI.—NOTES ON THE GREEN SLATES AND PORPHYRIES OF THE NEIGHBOURHOOD OF INGLETON.

By HENRY ALLEYNE NICHOLSON, D.Sc., M.B., F.G.S.

THE occurrence of certain of the Lower Silurian Rocks of the Lake-district beneath the Scar Limestone of Yorkshire, on a line between Ingleton and Settle, has been long known, and has been noticed both by Professor Phillips (Trans. Geol. Soc. 2nd series, vol. iii. p. 1), and by Professor Sedgwick (Quart. Journ. Geol. Soc. vol. viii. p. 35). More recently the rocks in question have been shortly described in a paper by Mr. Hughes, of the Geological Survey (GEOL. MAG. Vol. IV. p. 346). Having had the opportunity of visiting Ingleton in company with Professor Harkness, and subsequently alone, I have collected the following brief notes of the Silurian strata which are seen in that locality, and which belong to the Green Slates and Porphyries of the Lake-district.

The section which I propose to describe is the one afforded by the Dale Beck, which runs to the north-west of Ingleborough from Chapel-le-Dale to Ingleton, and is in length between one and a half and two miles. In the course of this stream the Silurian Rocks have been exposed by denudation, and are seen, in a remarkably clear section, to be unconformably overlaid on both sides of the valley by nearly horizontal beds of Scar Limestone. The section appears to be an ascending one down the valley, and the following is the sequence of the beds exhibited.

I. The highest beds exposed in the valley are a series of ordinary, cleaved, felspathic ashes, or Green Slates, with some intercalated trappean beds, the whole striking N.W. and S.E., and having a nearly vertical cleavage.

II. These slates are succeeded to the S.W. by a fine-grained, greenish-gray felspathic trap, in parts slightly hornblendic and micaceous. This trap is continued nearly as far as Dale-barn, forming opposite this point a series of well-marked glaciated bosses. Here it has intercalated in it a band of slates about 30 feet in thickness, and it assumes a slaty texture in parts. Above this slate-band the trap in places becomes highly porphyritic, consisting of a green felspathic base, containing numerous crystals of red felspar, with masses of crystalline quartz, specks of hornblende, and flakes of mica. Its composition, however, is very variable, and it passes directly into fine-grained trap on both sides. Blocks apparently of this porphyritic trap are found nearly a mile and a half down the stream; but these are much more highly quartzose in composition, and have a decidedly conglomeratic appearance. As no rocks of this kind can be found *in situ*, it is impossible to speak exactly as to the nature of these isolated boulders.

III. After passing over an interval of about one third of a mile in which there is no rock-exposure, a great series of greenish-gray slates and interbedded felspathic traps is reached. The slates retain their N.W. and S.E. strike, and have a nearly vertical cleavage, but the bedding can scarcely be made out. Some of the traps are of considerable thickness, others are mingled with slaty bands, and all are much intersected by veins of quartz. Some are dark-gray in colour, but they are mostly of a light greenish gray. They are all very fine-grained, and are devoid of distinct crystals.

IV. These are succeeded by a very thick band of ordinary Green Slates, containing a few small bands of trap.

V. A massive felspathic trap, of great thickness, and intersected by numerous quartz-veins. In mineral characters this is exactly similar to those already described, being fine-grained, greenish-gray in colour, slightly hornblendic, containing scattered flakes of mica, weathering brown, and effervescing faintly on the weathered surfaces and in the minute fissures of the stone.

VI. This trap is overlaid by a second great band of slates, which has been largely worked on both sides of the river. They form a fine-grained, greenish-grey slate, sometimes micaceous, and having a nearly vertical cleavage, which appears to coincide with the bedding, as shown by the existence of ripple-marking upon many of the cleavage-planes.

VII. Close below the slate quarries, by the side of the stream, the slates are seen to be surmounted by a light-brown granular felspathic trap or felstone, gritty-looking, and of small thickness.

VIII. Above this there comes on a band of gray, cleaved, flaggy, and calcareous shales, with a few obscure organic remains upon the cleavage-planes, amongst which are a species of Orthis and a large Orthoceras (probably *O. Brongniarti*).[1] These shales are in parts nodular, and they effervesce freely when treated with acids.

The further continuance of the section upwards is here interrupted by a fault, running parallel to the Craven fault, whereby the Scar-Limestone is brought down against the Silurian Rocks.

Correlation with the Green Slates and Porphyries of the Lake-District.—When we compare the Green Slates of the neighbourhood of Ingleton with those of the typical area in the Lake-district, many points of resemblance are observable, and a few notable differences. In both regions the series of rocks in question consists essentially of alternations of bands of felspathic ashes, with cotemporaneous igneous rocks, or traps, the ashes being usually cleaved, and being sometimes replaced by flaggy shales containing fossils. In the Ingleton section, on the whole, the slates are more largely developed in relation to the thickness of the traps, than is the case in the Lake-district, and there does not appear to be a well-marked series of trappean rocks at the base of the group, as there is in many parts of the main area. As regards the character of the Slates themselves, they are in many respects undistinguishable from those of the Lake-country, but they are much finer grained than the latter are as a rule, and there appears to be a total absence of breccias and amygdaloidal ashes.

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[1] In the excellent paper by Professor Sedgwick already referred to, the following fossils are stated to occur in this band of shales:—*Stenopora fibrosa*, Goldf.; *Halysites catenularius*, Mart.; *Orthis Actoniæ*, Sow.

The traps differ more conspicuously from those of the Lake-district, though the latter would yield examples in all respects undistinguishable. I may instance especially the greenish-gray trap which usually forms the base of the Green Slate series in the Lake-district, as seen at Keld Beck near Shap, (in many places this bed departs from these characters, and becomes highly hornblendic). Speaking generally, the traps of the Ingleton section have a much greater sameness than those of the Lake-district; they are finer-grained; and they are much less often porphyritic. They are likewise much less hornblendic than the majority of the traps of the Lake-mountains, and there is nothing like a genuine diorite or amygdaloid. The presence of free quartz in one of the Ingleton traps is noticeable, since in the Lake-district this is only the case with the intrusive rocks, and does not occur in any of the interbedded felstones with which I am acquainted.

The fossiliferous shales, which complete the section here, may be the equivalent of the " Dufton Shales " of the Lake-district, or they may represent the Coniston Limestone, the latter view being, perhaps, the most probable, since they effervesce freely with acids.

The apparent thickness of the Green Slates and Porphyries in the Ingleton section is stated by Mr. Hughes to be about 10,000 feet, but I should be disposed to believe with that observer, that there must be a repetition of some of the strata by a fault or by a concealed fold, either of which it would be very difficult to detect owing to the sameness of the beds, the prevalence of cleavage, and the absence or indistinctness of bedding.

NOTICES OF MEMOIRS.

The Salt Deposits at Stassfurt, in Prussia.

At a meeting of the Chemical Section of the Glasgow Philosophical Society, held on January 18th, Messrs Bald and MacTear communicated a paper on the Salt Deposits at Stassfurt. The southern part of the North German basin is divided by the Hartz into two portions, known as the Thuringian and the Magdeburg Halbertstader basins, in which salt has been raised for a lengthened period.

In the Magdeburg basin the salt rests on New Red Sandstone; in the Thuringian basin on Muschelkalk and Magnesian Limestone. Stassfurt is situated in the Magdeburg basin. Here and at Erfurt the Salt is mined, at all the other places in the district it is obtained by means of brine wells.

In the Prussian mine at Stassfurt, Salt was reached at a depth of 816 feet, after the following strata had been passed through, namely:

Alluvial Soil	27 feet.
New Red Sandstone	576 ,,
Gypsum, Anhydrite, and Marl	213 ,,
Salt.	

At a bore-hole at Schonebeck, some distance from Stassfurt, the salt was 1,480 feet from the surface, the rocks passed through being

Alluvial Soil	25 feet
Keuper, with Lettenkohle (an impure form of Brown-coal)	211 ,,
Muschelkalk	1067 ,,
New Red Sandstone	1680 ,,

The brine contained but 7½ per cent. of common salt.

Accounts are given of several other bore-holes in the same locality, showing considerable variations in the depths at which the Salt is reached, but the most important and interesting account relates to a shaft sunk at Stassfurt, which reached pure Salt at a depth of 1,066 feet from the surface. The beds penetrated were as follows:—

Alluvial Soil	27 feet.
Sandstone, with some schist and grey limestone	576 ,,
Gypsum and Anhydrite	192 ,,
Bituminous matter mixed with Anhydrite and Common Salt	21 ,,
Potash Salts	158 ,,
Rock Salt (the upper part mixed to a considerable extent with Anhydrite)	92 ,,

At this depth (1066 feet) lateral workings were commenced, the Salt being wrought in a manner somewhat similar to our long-wall system of coal-mining.

The total thickness of the Salts was found to be 1,197 feet; these the authors consider in detail. The lowest beds comprised 685 feet of pure Rock Salt, with thin layers of Anhydrite ¼-inch thick, dividing the Salt at intervals of from one to eight inches. Then comes a bed, about 200 feet thick, composed of

Chloride of Sodium	91·20
Anhydrite	0·66
Polyhalite	6·33
Hydrated Chloride of Magnesium	1·51

Higher up, the gradual disappearance of the more insoluble salts is manifest; the deposit contains but 2 per cent. of anhydrite, to 60 per cent. of common salt, and from 17 to 20 per cent. of Kieserite (monohydrated sulphate of magnesium), used in the preparation of Epsom Salts. In the uppermost beds the insoluble salts are entirely absent, the average composition being:—

Carnallite	55
Common Salt	25
Kieserite	16
Hydrated Chloride of Magnesium	4

In conclusion, the authors recommend the Salt mines as well worth a visit. To the scientific and non-scientific any trouble will be amply repaid, for apart from the high geological interest of the deposits, there is great attraction in the beauty of the passages and chambers in the interior of the mine, decked with magnificent crystals of the chlorides of sodium and potassium, sparkling and *glistening in the* light of the lamps.—Abridged from the "Chemical *News," February* 5th and 12th, 1869.

REVIEWS.

I.—MONOGRAPHS PUBLISHED BY THE PALÆONTOGRAPHICAL SOCIETY. February, 1869. Vol. XXII. (Issued for 1868).

THE pleasant task again falls to our lot to announce the issue of the twenty-second volume of the publications of this Society. We do so with more than usual good-will on this occasion, because the issue of this volume wipes off all arrears due from the Society to its subscribers, and leaves them nearly twelve months in which to produce the volume due to its members for the current year's subscription.

The present fasciculus of Monographs is made up of:—

1. Supplement to the Fossil Corals, Part II., No. 1. Corals from the White Chalk, the Upper Greensand, and the Red Chalk of Hunstanton, Plates I.-IX., by P. Martin Duncan, M.B. Lond., F.R.S., F. and Sec. Geol. Soc. The nine plates which accompany this part are by De Wilde. The genera illustrated and described by Dr. Duncan are *Caryophyllia* (3 species); *Onchotrochus* (2 species); *Cœlosmilia* (6 species); *Parasmilia* (3 species); *Diblasus* (1 species); *Smilotrochus* (4 species); *Cyathopora* (1 species); *Favia* (1 species); *Thamnastræa* (1 species); *Cyclolites* (1 species); *Podoseris* (2 species).

2. Fossil Crustacea—Order *Merostomata,* Part II. *Pterygotus bilobus,* by Henry Woodward, F.G.S., etc. This includes four varieties, viz., *inornatus, crassus, perornatus,* and *acidens,* illustrated with six plates by Hollick and Fielding. The specimens described in this part are all from Lesmahagow in Lanarkshire, and give us most complete details of structure, a rare occurrence in Silurian fossils.

3, Fossil Brachiopoda, Part VII., No. 3. of the Silurian Brachiopoda, by Thomas Davidson. F.R.S., Plates 23-37. Containing *Rhynchonella* (16 species); *Orthis* (52 species); *Triplesia* (3 species); *Atrypa* (2 species); *Cyrtia, Eichwaldia, Porambonites,* and *Strophomena*; illustrated in all by 390 figures!

It affords us great pleasure to know that Mr. Davidson is once more returned to England, and we hope his health and strength may be spared to finish this grand monograph, which is *all his own.*

4. The Liassic and Oolitic *Belemnitidæ,* Part IV., by Professor Phillips, M.A., LL.D., F.R.S., etc., Plates 21-27, with descriptions and illustrations of sixteen species. Geologists in the Oolitic and Liassic districts will rejoice to secure this work, for of all difficult things to deal with, in the way of determining their species, the guards of Belemnites are the most so. The Plates for this monograph continue to be drawn and printed in Paris. Those of *B. ellipticus, B. Aalensis,* and *B. giganteus,* are particularly effective and bold.

5. Professor Owen contributes No. III. to his Fossil Reptilia from the Kimmeridge Clay, in which he describes and figures: Palatal surface of skull and upper surface of lower jaw of *Pliosaurus grandis,* and part of cranium and lower jaw of *Pliosaurus trochanterius,* both

from the Kimmeridge Clay of Dorset, and obtained by J. C. Mansel, Esq., F.G.S., of Longthorns, Blandford. Also right-hand paddle of *Pliosaurus Portlandicus*, from the Oolite of the Isle of Portland.

6. The British Pleistocene Mammalia, by W. Boyd Dawkins, M.A., F.R.S., etc., and W. A. Sanford, F.G.S., Part III. This part contains plates and descriptions of limb-bones of *Felis spelæa*, and the jaw and occiput of skull of *Felis lynx*; this latter carnivore is new to England, and was obtained by Dr. Ransom from " Yew Tree Cave," a fissure in the Permian Limestone in Pleasley Vale, Derbyshire. Six plates illustrate this part, many of which are of double size.

Who would have believed, fifty years ago, that such a yearly volume could be issued by any Society for such a small subscription as a guinea annually?

Mr. Wiltshire, the indefatigable Honorary Secretary, promises that the 1869 volume shall appear in the autumn.

II.—PHYSICAL ATLAS FOR SCHOOLS.

A NEW and Enlarged Edition of the School Atlas of Physical Geography, illustrating in a series of Original Designs the Elementary Facts of Geology, Hydrography, Meteorology, and Natural History, has been prepared by Mr. Alexander Keith Johnston, Geographer in Ordinary to Her Majesty for Scotland, and Author of the Large Physical Atlas, the Royal Atlas, etc. (Published by Blackwood and Sons.)

Now that earnest efforts are being made to impart instruction in all the various branches of Natural Science in our public schools, we hail with pleasure the appearance of every work calculated to help the teacher in his task and to attract and interest the pupil: for without such aids it is but sorry dull work for both

In this little Atlas we have 20 plates, printed in colours (each measuring 12 inches by 9 inches), and divided into—(1) Illustrations of Chartography and Climatography, 1 plate; (2) Physical Geology, 4 plates; (3) Topography, 5 plates; (4) Hydrography, 4 plates; (5) Meteorology, 3 plates; (6) Natural History, 3 plates. These are accompanied by 42 pages of letter-press, giving a detailed description of the plates, which should be read over carefully and mastered by the teacher privately, that he may be conversant both with the maps and their explanation before using them in the school.

Four of the plates are new and now appear for the first time; these are:—Plate 2. Illustrations of the Action of Rain and Streams, and Ice and Snow; Plate 3. Illustrations of Sea-Action and of Volcanic Action and Movements of the Earth's Crust; and Plates 13 and 14, which together form a Hydrographic Map of the British Isles, showing the River-basins, the Rainfall and the Elevation of the Land in Contours.

The author acknowledges the valuable aid he has received from Mr. Archibald Geikie, F.R.S., Director of the Geological Survey of Scotland, in the design and execution of the geological illustrations which form Plates 2 and 3; these will be found of great assistance in explaining the way in which rain and streams, ice and snow, sea-action and volcanos, have tended to modify the surface of our earth, and will enable the scholar more readily to understand the cause which has produced any local alteration of a coast-line, a valley, or mountain, and thus impart a new zest to his studies and a fresh interest to each place he may visit at home or abroad.

The maps illustrating the distribution of plants, animals, and of the various races of mankind, will be sure to awaken an interest in the scholar, and the teacher will find the veriest dullard may be taught much that is useful by this method of visual education.

We hope this Atlas may find its way into every school; all Public Schools ought to possess a copy of Mr. Johnston's large Physical Atlas of Natural Phenomena in their library.

III.—REPORTS OF THE RUGBY SCHOOL NATURAL HISTORY SOCIETY FOR THE YEARS 1867 AND 1868 (pp. 58 and 60). Rugby: 1868 and 1869. Tait and Sons.

"A DEMAND for the introduction of science into the modern system of education has increased so steadily during the last few years, and has received the approval of so many men of the highest eminence in every rank and profession, and especially of those who have made the theory and practice of education their study, that it is impossible to doubt the existence of a general, and even a national desire to facilitate the acquisition of some scientific knowledge by boys at our public and other schools."

Such are the words of the opening paragraph of the Report of the Committee appointed by the Council of the British Association for the Advancement of Science, to consider the best means for promoting scientific education in schools (read at Dundee, 1867).

Natural science is now taught at Harrow and Rugby, and we believe it has even invaded the classic shades of Eton.

The general plan at Rugby appears to be that new boys learn Botany their first year, Mechanics their second, Geology their third, and Chemistry their fourth. Out of a school of 450 to 500 boys (says the report already quoted) about 1-10th generally were in the natural science classes. The committee go on to say, "It is very desirable that boys should obtain some knowledge of Geology. . . . . Perhaps a larger proportion of boys are interested in the subject than in any other; but the subject presupposes more knowledge and experience than most boys possess, and their work has a tendency to become either superficial or undigested knowledge derived from books alone. The lectures include the easier part of Lyell's Principles, *i.e.* the causes of change now in operation on the earth; next, an account of the phenomena observable in the crust of the earth, stratification and its disturbances, and the construction of maps and sections; and, lastly, the history of the stratified rocks and of life on the earth. These lectures are illustrated by a fair geological collection, which has been much increased of late, and by a good collection of diagrams and views to illustrate geological phenomena" (p. 12).

To the question, *Do the boys really care about Geology?* the pages of the Reports now before us are the best possible answer. They have started a Natural History Society for themselves, and with the patronage and assistance of two or three of the masters (especially of Mr. J. M. Wilson, M.A., F.G.S.), they really bid fair to set a good example to many local Field-clubs and Natural History Societies of grown-up men, who, certainly, as far as years and experience go, have the advantage of them.

The Society was founded March 23rd, 1867. It held twelve meetings in that year, the average attendance at which was twenty-five and the largest number thirty-three. In 1868, sixteen meetings were held, the average attendance at which was thirty-nine, and the largest number sixty-two! exhibiting a most encouraging state of progress.

The papers, necessarily, are somewhat elementary in character. E. Cleminshaw, in the first Report, gives a paper "On the Natural History of the Rugby Lias;" and A. C. Bruce "On the accurate division of the local Lias at Rugby into Zones by their Fossils, more especially by their Ammonites." A list of local Lias Fossils is also given. (The term "Crustacean *scales*"[1] is bad; "Fish-scales" would be correct, but "portions of Crustacea"—stating whether limbs or articuli of body—would be best). "Collecting Fossils," says the writer of one of these papers, E. Cleminshaw, "is undoubtedly the chief incitement to the study of geology;" and there can be little doubt that Rugby will turn out some good geologists, from the opportunity which is afforded to the boys to get good fossils from the Lias quarries. We are glad to see the President ever ready, as is his bounden duty, to correct bad deductions in geology, and we hope he will do the same in palæontology and natural history. The *Siphuncle* of the Ammonite and Nautilus *does not "contain some liquid,* which it has the power of secreting, and which liquid would make the shell heavier in proportion to its bulk, and so it would sink;" nor, "upon the withdrawal of the liquid would the shell become specificially lighter and would ascend." The *Siphuncle* (as the writer correctly states) has no connection with the interior of the chambers of the shell, and its contents, whether present or withdrawn, would be quite inadequate to disturb the equilibrium of the animal. We must seek another explanation for the siphuncle than that of a pneumatic apparatus.[2]

The 1868 report contains a paper "On the Volcanoes of the Lower Eifel Mountains;" "On the River Gravels," etc. etc. Mr. Wilson contributed papers during both years. The Natural History papers and notes exhibit a more than ordinary share of ability and promise, and they all denote work done lovingly and in right good earnest.

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[1] Report for 1867, p. 55.

[2] We would recommend to Mr. Cleminshaw's study some notes "On the Form, Growth, and Construction of Shells," by the late Dr. S. P. Woodward; "Intellectual Observer," vol. x. p. 241, for Nov. 1866, and vol. xi. p. 18, for Feb. 1867 (especially pp. 28 and 29). A third article on the "Economic Uses of Shells and their Inhabitants" appeared in the April number of the same year (1867); and the "Student and Intellectual Observer" for June or July next will probably contain some notes *specially on the shells* of the Cephalopoda.—Edit.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—I. March 10th, 1869.—Papers read: 1. "On the Origin of the Northampton Sand." By John W. Judd, Esq., F.G.S., of the Geological Survey of England.

This paper was an attempt to base on the study of a rock, both in in the field and the laboratory, a complete and consistent theory of the conditions of its original deposition, and of the sequence and causes of its various metamorphoses.

The Northampton Sand was described as consisting of various strata, usually of an arenaceous character, which frequently pass, both vertically and horizontally, into a ferruginous rock, the well-known Northamptonshire ore.

The different features presented by the formation in various localities were then indicated; and the lithological, microscopical and chemical characters of its constituent rocks described at length.

These characters were shown to point to the conclusion that the beds were accumulated in a delta of one or more great rivers.

Arguments were then adduced in opposition to the theory of the formation of ironstones by direct deposition, and in favour of the hypothesis that the Northamptonshire ore consisted of beds of sand altered by the percolation through them of water containing carbonate of iron.

The cause of the re-distribution of the iron in the rock was then discussed, and, in opposition to the views of Mr. Maw, who has referred the phenomena in question to "*segregation*," they were all shown to be easily capable of explanation on well-known chemical principles, and to be due to the action of atmospheric water finding access to the rock by its joints and fissures.

The paper concluded with a sketch of what was inferred to be the history of the rock from its accumulation to the present time, and some remarks on the varied and important effects of water when acting under different conditions on rocks.

DISCUSSION.—Mr. Maw agreed on the whole with the author as to the chemical changes which had taken place in these beds. He had little doubt of the carbonate of iron having replaced carbonate of lime, as had been originally suggested by Mr. Sorby, and of there having at one time been a much larger proportion of protoxide in the beds. He did not, however, think that the banded arrangement of the protoxide of iron could be accounted for on any simple chemical theory. He had found by analysis that the proportion of iron in the dark and light areas of variegated rocks bore no direct proportion to each other. In some cases the whole of the iron in the lighter portions had been exhausted. The excess of phosphoric acid in some patches could, he conceived, be only accounted for by segregational action. The thickness also of the environing band was always proportional to the area enclosed, and not by any means uniform round blocks of different sizes. It therefore seemed to be due to segregation from the included mass from which a certain portion of the iron had been withdrawn.

Mr D. Forbes objected to the name of Northampton Sands as applied to rocks so slightly arenaceous. He thought the phosphate of iron present might be principally due to the organic remains in the original limestone, which had been replaced by the carbonate of iron. He remarked that in many of the blue ironstones there was no sulphur present. He did not agree with the author's views as to the cessation of the chemical action by the formation of the bands of hydrated peroxide of iron. The bands on the contrary, were formed one within the other, and arranged concentrically in the blocks in certain cases, and appeared due to some sort of segregation.

Professor Ansted justified the application of the name of Sands to these Northamptonshire beds. Though many phenomena could not be accounted for by simple mechanical and chemical action as distinct from what had been termed segregation, he was inclined to accept Mr. Judd's views as regarded these beds.

Professor Morris considered that the sand was characteristic of only the upper portion of this formation, other beds being more oolitic and vesicular in character. The subjacent strata were of an impermeable character; and this, he thought, had had much to do with the formation of the ironstone beds. Some of the blue ironstones contained as much as 5.5 per cent. of phosphate of iron. There were two varieties, like those of Rosedale, the one magnetic and the other not. In Lincolnshire the marlstone near the surface had been converted into ironstone; and this fact corroborated Mr. Judd's views.

Professor Maskelyne had observed these sands some years ago near Banbury, and had noticed that many of the hollow nodules of ironstone usually contained a kernel of ochre. Besides carbonic acid, he thought chlorine had played an important part in the formation of the ironstone. In some of the aëtites he had mentioned, there was a thin shell of silica. The core in the centre was probably left by the dissolution of the limestone from the interior. Some of the disturbance of the rock might be due to expansion from chemical causes.

Mr. Roberts remarked that it was quite possible to obtain oxide of iron soluble in water. Perchloride of iron dissolves oxide of iron; and if this be dialyzed, the crystalloid chloride diffuses away, leaving the oxide of iron in solution.

Mr. Judd, in reply, remarked that he regarded these beds as having been originally not limestones, but sands, which were converted into ironstones by the deposition of carbonate of iron within them. The name "Sands," if a mineral character was to give the name, was the best term that could be applied to these beds. He had seen nothing in this ironstone for which recognised chemical causes would not account, and he therefore objected to the introduction of unknown agencies to explain them. In nearly all instances the rich dark bands were formed parallel to joint- and bedding-planes. The phosphate of iron might have been removed by solution from certain parts, and the richness in phosphorus of the green ore need not be due to segregation. He thought the beds referred to by Professor Maskelyne were probably the Marlstones rather than the Northampton Sands. He regarded the presence of carbonic acid as certain, while that of chlorine was at the best doubtful, and he therefore was unwilling to call in its agency.

2. "On the Occurrence of Remains of *Pterygotus* and *Eurypterus* in the Upper Silurian Rocks in Herefordshire." By the Rev. P. B. Brodie, M.A., F.G.S.

In this paper the author described the occurrence of numerous specimens of Crustacea, chiefly belonging to the genera *Eurypterus* and *Pterygotus* in beds of Upper Silurian age, probably the "passage beds," in the Woolhope district and near Ludlow.—Mr. H. Woodward said that he had examined the specimens referred to, but he did not think that they presented any new forms.

II. March 24th, 1869.—Papers read: 1. "On the Cretaceous Strata of England and the North of France, compared with those of the West, South-west, and South of France, and the North of Africa." By Professor Henri Coquand, of Marseilles. Communicated by J. W. Flower, Esq., F.G.S.

In this paper the author indicated that the agreement between the Cretaceous strata of England and the North of France, as far as the Basin of Paris, is such that the same classification may be applied to the whole, but that, in advancing to the west and south, new beds make their appearance. This is also the case in Algeria, the palæontological differences between the Cretaceous rocks of that country and those of the Anglo-Parisian basin being so great as to lead at first sight to the impression that they belonged to two different formations. The author arrived at the following classification and nomenclature of the divisions of the Cretaceous rocks, the palæontological characters and geographical range of which were described in the paper:—

I.—UPPER CRETACEOUS.

A. Red Lacustrine Sandstone of Vitrolles (= Garumnien of Leymerie).
B. Dordonien.
C. Campanien (= Upper Chalk.
D. Santonien (= Superior Lower Chalk).
E. Coniacien (Sandstone).

II.—MIDDLE CRETACEOUS.

F. Provencien.
G. Mornasien.
H. Angoumien.
I. Ligerian (= Inferior Lower Chalk).
J. Carentonien.
K. Gardonien.
L. Rhothomagien (= Upper Greensand and Chalk-marl).
M. Gault.

III.—LOWER CRETACEOUS.

N. Aptien.
  1. Upper.
  2. Middle. } = Lower Greensand.
  3. Lower. }
O. Neocomien.
P. Valengien.

DISCUSSION.—Mr. J. W. Flower called attention to the great discrepancy between the thickness of the Cretaceous beds in France and those in England. This was principally made up by several strata entirely wanting in England, and for the most part of a totally different character, being either of freshwater origin, or else Hippurite limestone. Another great feature of distinction was the presence of coal-bearing beds with numerous layers of lignites. That these beds were of Cretaceous origin was proved by their occurrence under undoubted Eocene beds. Among the fossils of the Algerian Chalk were those of several genera unknown in the Cretaceous beds of England.

Dr. Duncan suggested that possibly the Upper Coal-beds might be the equivalent of those of Aix la Chapelle. He doubted whether any decided synchronism in strata, spread over so extensive an area as that of the Cretaceous deposits, could be established by the mere occurrence of certain fossils in them; nor could he attach much value to supposed specific differences in shells of such character as *Ostrea.* The variations in condition in the sea-bottom would lead to variations in the Testacea, and there were signs to be found of great variations going on before the form of *Hippurites* was developed. He regarded *Hippurites* as a modified form of *Chama* or *Caprina*, and thought it was parasitic on coral reefs in the same way as its modern representative. He accounted for its presence by the great development of corals at that period in the Cretaceous seas.

Mr. Judd remarked upon the repeated changes which had occurred in the opinions of foreign geologists as to the limits of the various "stages" into which the Cretaceous rocks might be divided, and indicated that this of itself was equivalent to the abandonment of the principles laid down by D'Orbigny. He further observed that in the recent changes, even as evidenced by M. Coquand's paper, there was a tendency to approach the views as to the classification of the Cretaceous beds established by the late Professor Edward Forbes, and generally accepted by English geologists.

Professor Morris observed that the object of the French geologists had been to remove the opinion that mere mineralogical characters were sufficient to distinguish Cretaceous strata. He called attention to the existence of copper and antimony in some of the Lower Cretaceous beds, and to the great break that appeared to exist between the Lower and Middle Cretaceous series. Another curious point was that in the South of France there appeared to be passage-beds between the Upper Cretaceous and Eocene beds.

Professor T. Rupert Jones remarked on the analogy between the passage from the Chalk to the Eocene Tertiaries, as supposed to be exhibited in the South of France and in the Nebraska territory of America. He pointed out that the Cretaceous beds of France having been deposited, not in one sea, but in separate sea areas, they were, of course, difficult of correlation.

2. "On the Structure and Affinities of *Sigillaria* and allied genera." By W. Carruthers, Esq., F.L.S., F.G.S.

The author indicated the characters of the medullary rays of dicotyledonous stems, and stated that these stems have a vascular horizontal system connected with the axial organs, in which respect the dicotyledonous and acrogenous stems agree. The woody columns of *Stigmaria* and *Sigillaria* are destitute of medullary rays, the structures previously described as such being the vascular bundles running to the rootlets and leaves. Hence the author concluded that *Sigillaria* is a true cryptogam, a position supported by the characters of the organs of reproduction as described by Goldenberg. The paper concluded with an enumeration of the forms of fruits belonging to *Sigillaria* and its allied genera, with indications of the existing forms to which they most nearly approach.

Discussion.—Professor Morris insisted on the necessity of the student of fossil botany being thoroughly acquainted with modern botany also. It was from specimens discovered many years ago by Mr. Prestwich that the true nature of the *Stigmariæ* had been discovered, and he quite agreed with the author in regarding them as cryptogams, and in no way connected with gymnosperms. The abundance of cryptogamic spores in coal was hardly at present appreciated. There were some varieties of coal almost exclusively composed of such spores.

3. "On the British Species of the Genera *Climacograpsus*, *Diplograpsus*, *Dicranograpsus*, and *Didymograpsus*. By H. Alleyne Nicholson, D.Sc., M.B., F.G.S.

The author stated that all the genera referred to in this paper appear to be exclusively of Lower Silurian age,—*Climacograpsus* and *Diplograpsus* occurring almost throughout the Lower Silurian series, whilst the other two genera belong chiefly to the Llandeilo series of rocks, or to strata of corresponding position out of Britain.

The British species of the above genera admitted by the author are:—

Climacograpsus tertiusculus, His.
—— *bicornis*, Hall.
—— *tuberculatus*, Nich, sp. n.
Diplograpsus pristis, His.
—— *mucronatus*, Hall.
—— *Whitfieldii*, Hall.
—— *Harknessii*, Nich.
—— *confertus*, Nich.
—— *cometa*, Gein.
—— *palmeus*, Barr.
—— *acuminatus*, Nich.
—— *vesiculosus*, Nich.
—— *pristiniformis*, Hall.
Diplograpsus tamariscus, Nich.
—— *pusillus*, Hall.
—— *nodosus*, Harkn.
—— *pinnatus*, Harkn.
——, sp.
Dicranograpsus ramosus, Hall.
Didymograpsus Murchisoni, Beck.
—— *affinis*, Nich., sp. n.
—— *divaricatus*, Hall.
—— *anceps*, Nich.
—— *flaccidus*, Hall.
—— *sextans*, Hall.

The paper included descriptions of the supposed embryonic states of several of the species.

Discussion.—Mr. Carruthers observed that he saw no reason, from what Dr. Nicholson said, for changing his opinion that *Diplograpsus vesiculosus* was a bad species. The enlargement of the axis was known in other species of the genus. The notion that this enlarged axis might be a "Grapto-gonophore" was more unlikely than any of Dr. Nicholson's former ideas on this subject. As to the anatomy of these organisms, it must be borne in mind that we were able to deal only with the hard parts. He entered at some length into the character and structure of Graptolites.

Dr. Duncan regarded Graptolites as being one of the most uncertain things in nature, to judge from the descriptions published of them. They were sometimes described partly by botanical terms and partly by hydro-zoological. The author had confused in his mind the meaning of the terms embryo and young, and had moreover brought needless difficulties into the case by assuming what appeared to be impossible affinities.

Mr. Hughes pointed out that the double-celled form of Graptolites did not occur in the Coniston Flags proper.

III. April 14th, 1869. Papers read:—1. "On the Coal-mines at Kaianoma, in the Island of Yezo." By F. O. Adams, Esq., Hon. Secretary of Legation in Japan. Communicated by the Secretary of State for Foreign Affairs.

The writer states that the works at Kaianoma have made considerable progress since they were reported upon by Mr. Mitford last year.[1] There are four seams of coal, each about 7 feet thick, from 50 to 100 feet apart. A tunnel has been driven through one of the seams for a distance of between 150 and 250 feet, and at an elevation of 430 feet above the sea. From this the coal obtained is carried down to the shore on the backs of men, mules, and ponies. The writer adds that there is abundance of coal "of the cannel description."

2. "On a peculiarity of the Brendon-Hills Spathose Ore-veins." By M. Morgans, Esq. Communicated by Warington W. Smyth, Esq., F.R.S., F.G.S.

The author described the Brendon-Hills as consisting of a Devonian slate, dipping S. by E. and N. by W. on the two sides of the axis of elevation. The cleavage laminæ dip S. by W. at an angle of 80°, and the cleavage-strike forms only a slight angle with that of the beds, which, however, is sometimes irregular. Veins of spathose iron-ore, very rich in manganese, occur in the slate; and the general dip of these appear to coincide with that of the cleavage-planes. The veins consist of thin "tracks" of softened clay-slate and quartz, with larger or smaller pockets of productive ore. These metalliferous portions do not descend parallel to the line of their dip, but slope more or less, usually to the west. The author stated that the veins have been segregated from the adjoining clay-slate, the unproductive portions of them occurring where the conterminous strata were not impregnated with sufficient ferruginous matter to produce a lode of iron ore; the slope of each productive part, called "endslant" by the author, is determined by the line of intersection of the plane of the vein with the boundaries of the ferruginous portions of the beds.

Discussion.—Mr. Etheridge thought that the great iron lodes of this district lay in the great faults which traverse the country, and in which there had been considerable downthrow to the North. In most cases in the Bristol district the lodes seem to have been formed at the bottom of the sea during the New Red Sandstone period by infiltration of salts of iron into the faults.

3. "On the Salt Mines of St. Domingo." By F. Ruschhaupt. Communicated by Sir R. I. Murchison, Bart., V.P.G.S.

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[1] See Quart. Journ. Geol. Soc. vol. xxiv. p. 511.

The author described the Cerro de Sal, or Salt Mountain of St. Domingo, which extends about three leagues in length, and consists, according to the author, of rocks "of the Red Sandstone class," and where the chief visible deposits of salt occur are principally gypsum-schists, sometimes very argillaceous. The salt is generally surrounded by an ash-like mass, consisting of gypsum and clay. The author compared the gypsum beds with those of the Keuper. The beds are thrown into a perpendicular position, and the same change is observable for miles in the Savanas. An immense body of salt, 250–300 feet broad, is exposed upon the north side of the mountain. The salt is very white and pure, and might easily be conveyed to the port of Barahona, about eighteen miles distant.

DISCUSSION.—Sir R. I. Murchison had been at a loss to understand how such beds of salt could coexist with shells of recent species in St. Domingo. The question seemed, however, to have been solved by the geological survey of many of the West Indian islands, which had determined that all these deposits were of Miocene age. In the majority of the islands there were no rocks so old as the Cretaceous, and he therefore suspected that there was an error on the part of the author in regarding the beds of St. Domingo as belonging to the Trias.

Prof. Ramsay thought it was more remarkable that any salt-deposits of the New Red Sandstone should exist than that there should be so many of Miocene age. There was not much probability of great salt-deposits of more recent date, as there had hardly been sufficient time for their formation, though in the Great Salt Lake and elsewhere such deposits were now forming. The reason why such old deposits of salts had been preserved appeared to be that the salt had been hermetically sealed up in impermeable marl as soon as the part of the salt which lay near the outcrop of the beds had been dissolved away.

Mr. Etheridge was satisfied that the shells from St. Domingo which came with the salt are of Miocene age. In other West India islands gypsum of Miocene age occurred, and pseudomorphs of salt. He recommended Mr. Sawkins's work on the Geology of the West Indies to the attention of geologists.

4. "A description of the 'Broads' of East Norfolk, showing their origin, position, and formation in the Valleys of the Rivers Bure, Yare, and Waveney." By R. B. Grantham, Esq. C.E., F.G.S.

The author described the general characters of the "Broads," or shallow lakes of East Norfolk, and indicated their connection with the river valleys. He regarded them as the last traces of great estuaries, now cut off from the influence of the sea by upheaval.

DISCUSSION.—Mr. J. Gwyn Jeffreys suggested a zoological as well as a geological examination of these lakes. If of marine origin, possibly some marine forms might be found still existing in them, as had been discovered to be the case in some of the lakes of Sweden.

Mr. Searles Wood, Jun., agreed that these broads were of later date than the excavation of the valleys. He cited Mr Prestwich's account of the boring at Yarmouth, which showed a large amount of silting up of the valley.

Mr. Prestwich inquired whether the amount of silt at the bottom of these broads had been ascertained, and whether any estuarine shells had been found in the beds at the bottom.

Professor Ramsay suggested tha tthe broads might be relics of the old valleys of the time when the Thames and other rivers of the east of England united with the Rhine and other continental rivers to flow into the Northern Ocean.

5. "On a peculiar instance of Intraglacial Erosion near Norwich." By Searles Wood, Jun., Esq., F.G.S., and F. W. Harmer, Esq.

The authors described the general structure of the valley of the Yare, near Norwich, in which the fundamental Chalk-rock is covered by the following drift-beds:—1, the Chillesford sand and clay; 2, pebbly sands and pebble-beds; 3, the equivalent of the contorted

Drift of Cromer; 4, the Middle Glacial sand; and 5, the Boulder-clay, The valley is hollowed out in these beds. Sewer-shafts sunk in the bottom of the valley near Norwich have shown the existence of an abrupt hole or narrow trough in the Chalk, having one of its sides apparently almost perpendicular. This is filled up in part by a deposit of dark blue clay, full of Chalk-débris, exactly resembling the Boulder-clay at a distance from Norwich, but quite different in character from that occurring in the vicinity (No. 5); and this is overlain in part by a bed of the Middle Glacial sand (No. 4), and in part by a Post-glacial gravel. The authors believed that this peculiar hole or trough was excavated by glacial action after the deposition of the bed No. 3, and that it belongs to the earliest part of the Middle Glacial period. At Somerleyton Brick-kiln, near Lowestoft, a perfectly similar bed occurs between the drift and sand (Nos. 3 and 4).

DISCUSSION.—The President inquired whether the perpendicular wall of chalk shown in the section could be due to the action of a glacier, as supposed by the author.

Mr. Prestwich suggested that the depression formed in the chalk in other districts by chemical action might possibly throw some light on the case.

Mr. Evans thought it possible there might have been a valley originating in a large fissure, and partly filled up with reconstructed glacial deposits.

Prof. Ramsay was inclined to accept the solution offered by Mr. Prestwich, and could not see any traces of the action of a glacier.

Mr. Etheridge thought the phenomena might be accounted for by a fault.

Mr. Hughes pointed out that the clay-bed was totally different from any of the beds supposed to have been let down.

Mr. Searles Wood. Jun., in reply, relied on the difference in character of this bed to prove that the case was not the result either of a fault or of beds being let down into a pothole. He had made a mistake in using the word "glacier" instead of "iceberg."

6. "On the Lignite Mines of Podnernuovo, near Volterra." By E. J. Beor, Esq., F.G.S.

The author states that the deposit of Lignite at Podnernuovo, near Voltarre, is of lacustrine origin, and consists of two parallel strata of compact coal about 2½ metres (=8 feet 4 in.) in thickness, separated by a thin stratum of marl, with marsh-shells. The lower coal-bed lies on a bed of marl with marsh-shells, and the upper bed is covered by a marine formation belonging to the Upper Miocene. The lignite comes to the surface near the Alberese, where it extends for a considerable distance. Some shifts occur bringing the upper bed down nearly to the level of the lower one; the inclination of the bed diminishes gradually, and the intervening stratum of marl decreases in thickness, and probably at last thins out altogether. The coal in the upper bed is better than that in the lower one. The author remarks that this lignite deposit differs from those of the neighbouring valleys in being purely of marsh origin, while they are Estuarine.

EDINBURGH GEOLOGICAL SOCIETY.—I. Seventh meeting, March 4th. Archibald Geikie, Esq., F.R.S., President in the chair.

Death of Lady Murchison.—The President referred to the recent death of Lady Murchison, an event which could not pass unnoticed by students of geology in Scotland. Sketching briefly some of the early journeys made by her husband and herself in this country, France, Germany, Switzerland, and Italy, he dwelt upon the great influence which she had exercised upon Sir Roderick Murchison in leading him into the paths of science, and encouraging him by her assistance. It was she who induced him to forsake the ordinary amusements of a retired cavalry officer, and devote himself to that branch of science in which he has so distinguished himself. For many years, and while her strength enabled her, she was his frequent companion by seashore, mountain, and glen, aiding him in his observations, and making for him those remarkable geological sketches of landscape for which the "Silurian System" and "Siluria" are so well known to Scottish geologists. It was of interest to remember that many of the fossils from which the true age of the Secondary rocks of Sutherland and the Western Isles was made out were collected by her. Throughout her long life she maintained a warm interest in all that related to the progress of science, and in all that might promote the happiness of those by whom science is cultivated. To Sir Roderick Murchison himself this Society, like all other geologists in this country, owed a debt of gratitude for the unequalled contributions which he had made to Scottish geology; but they were likewise indebted to him for acts of kindness which he had shown to the Society. It seemed but fitting, therefore, that the recent melancholy event should not pass away without some expression of sympathy with him, and of regret at the loss of one who, both by her own exertions and through the labours of her husband, has been so intimately associated with the history of geology in Scotland.

The following papers were then read:—1. "On the Silurian Beds of the Pentland Hills." Part 2. By John Henderson and D. J. Brown.

The first part of this elaborate paper was read before the Society in Session 1866-67, and appears in the Transactions for that year. The authors gave a brief *resumé* of the first portion of their joint paper. They stated that both the Wenlock and Ludlow formations were represented in the district of the Pentland Hills near the North Esk Reservoir. They described the beds as they occur in succession in the North Esk, noticing, in passing, their characteristic fossils. They showed that the uppermost vertical beds in this section, supposed to be of "Lower Old Red Sandstone" age by the Geological Survey, and to be of a very local nature, extended from the North Esk to the Lynn Water, a distance of two miles in the direct line of strike; and that the beds in the Lynn Water, termed Greywacke by Maclaren, and coloured Silurian on the Geological Survey's Map, do in reality overlie these supposed Lower Old Red Sandstone beds of the Geological Survey. They then proceeded to describe the uppermost beds in the Lynn Water, the lower of which, from their fossil contents, they identified as a continuation of the uppermost fossiliferous beds in the North Esk section. Above these fossiliferous beds in the Lynn Water, they were able to trace the Old Red Sandstone throughout its whole extent, overlain by vertical shales of apparently the same nature as those of the North Esk described by Maclaren as Greywacke. Reference was made to Maclaren's "Geology of Fife and the Lothians," in which the author shows that these rocks differ little in lithological character throughout the Esk and Lynn Water sections. Messrs. Henderson and Brown held that the whole of the vertical beds in the North Esk and Lynn Water sections formed one unbroken series. From the fact that they had found Ludlow fossils in the strata at the base of the supposed "Old Red" beds, and none of them exclusively passage-bed forms, they were of opinion that all the vertical beds seen in the Pentland Hills belong to the Silurian formation.

2. "The Fifeshire Gold Diggings of 1852 and their Lessons." By W. Lauder Lindsay, M.D., F.R.S.E.—Dr. Lindsay first gave an account of the various gold-manias in Scotland, etc., particularly that of West Lomond Hill, which lasted a month (in May, 1852), and was visited by probably 6000 gold-seekers. Here the substance obtained was iron pyrites from the Carboniferous limestone. The author considers such mistakes cannot again occur, so many persons having visited true gold-producing quartz-reefs and auriferous drifts in Australia and elsewhere. He had satisfied himself that Sutherlandshire was a true auriferous region.

3. "Preliminary Report on the Sutherlandshire Gold." By the same author. Dr. Lindsay having carefully compared the character of a sample of gold found at Kildonan, Sutherlandshire, obtained through Mr. P. G. Wilson, of Inverness, with samples from New Zealand, Nova Scotia, Leadhills, Scotland, concludes that the Kildonan gold is of high average quality. The amount in which it occurs has not yet been satisfactorily proved. Specimens of the Kildonan gold were exhibited. G. A. P.

II. The eighth meeting took place on the 18th March—George Lyon, Esq., in the chair. The following papers were read:—1. "Notes on the Geology of Derwentwater, in Cumberland." By Henry Alleyne Nicholson, D.Sc., M.B., F.G.S.

The author commenced by pointing out that the hills on the western side of the lake were very different in external features from those of the eastern side; the former being pointed and comparatively smooth, whilst the latter were extremely irregular, rough, and broken. The cause of this difference had remained unnoticed until the author (in November 1868), found that the western side of the lake was formed almost entirely of the Skiddaw Slates, which extended up to the mouth of Borrowdale; whereas the eastern side was composed of the igneous series of the Green Slates and Porphyries. The proper line of junction between the Skiddaw Slates and Green Slates was at Keswick, this line was continued for a short distance on the western side of the lake, the Skiddaw Slates being then repeated by a great E.N.E. and W.S.W. fault. (See Geol. Mag., Vol. VI., p. 105), On the eastern side of the lake, however, this did not occur, and the trap of the Castle Head, near Keswick, was conformably succeeded by a mass of breccia corresponding to the great slate band at the mouth of Borrowdale. There was thus a difference of more than two miles from north to south between the position of this well-marked horizon near Keswick and its situation in Borrowdale; the difference being caused by the above-mentioned fault. The author likewise adduced reasons for the belief that the absence of this fault on the eastern side of the lake was due to the presence of a second fault having a north and south direction, and running along the eastern shore of the lake. As regards the origin of the depression in which Derwentwater is situated, the author held that it is to be ascribed to the ordinary denuding agents, but especially to glacial action. At the same time he could not doubt but that the faults which he had shown to exist had powerfully co-operated in the production of the valley. He did not suppose that faults caused open fissures, which were subsequently widened into valleys; and he was not aware that any one held this view. On the contrary, it was simply held that faults might constitute lines of weakness along which denuding agencies would meet with less resistance than elsewhere; this being partly due to the inevitable breakage and disturbance of the rocks near the line of fracture, and partly to the fact that rocks of unequal hardness were often opposed to one another for a great distance in consequence of the displacement. This latter cause was specially manifest in the case of Derwentwater—one side of which was composed of the comparatively yielding Skiddaw Slates, and the other of the igneous series of the Green Slates and Porphyries. And there were unmistakable proofs that this was due to faulting, and was not caused by the want of conformability, which the author had recently shown to exist between the two formations in question.

2. "On the Carboniferous Limestone Strata at Southerness, Kirkcudbrightshire," by William Jolly, H.M., Inspector of Schools. Illustrated by specimens of the fossils there found.

After referring to the great beauty of the road between Dumfries and Southerness, the author described the Granite, Carboniferous, and Silurian rocks, along the Arbigland shore near that cape. At Southerness occurs an isolated triangular patch of the Carboniferous strata, part of a belt of the same, stretching from the head waters of the Liddel to the mouth of the Nith. The rocks here belong to the Carboniferous limestone series between the true Coal-measures and the Calciferous Sandstones, and exhibit some remarkable phenomena. Granite, Silurian, Carboniferous sandstone, shale, limestone, ironstone, coal, and trap, are seen in the course of a short walk along the shore; the great variety of strike running in the shortest distance to every point of the compass, and showing strange examples of curved stratification. Great change in the dip of the rocks from horizontal to beyond perpendicular; numberless and striking "troubles," slips, dykes, and foldings; all exhibited as in a seaside museum ready for the student. Fossil corals may be collected, and whole beds of corals seen, with their dome-shaped masses in natural position as they lived in the Carboniferous sea. Ripple-marks, worm-castings, annelide-borings, and footprints are also well shown on the exposed surfaces. A list of the fossils found was given. Other geological phenomena were also referred to, as sea-action in the formation of caves, stacks, and pots Glacial *debris*, and recent deposits. The shore is remarkable, also, botanically, plants being found there rare or unknown in other parts of Scotland, of which a list was given by the author. Altogether, the Arbigland shore seems worthy the attention of the geologist, botanist, antiquarian, and tourist. G. A. P.

NORWICH GEOLOGICAL SOCIETY.—The monthly meeting of this Society was held on March 4th. The Rev. J. Gunn, F.G.S., President, in the chair.

A tooth of *Mosasaurus* in a flint, found by Mr. J. E. Taylor, was exhibited by the Honorary Secretary.

The President stated that some of the bones found on the site of the King's Lynn Dock were those of a large wader, most probably a Crane. Professor Newton considered that the largest tibial bone probably belonged to the large extinct Crane, figured and described by M. Milne Edwards.

Mr. F. W. Harmer communicated a paper "On the so-called Crag of Belaugh and Weybourne." The author said it was generally held by geologists that the Norwich Crag was the Fluvio-marine, or estuarine equivalent of the upper part of the Red Crag which occupied the country in Essex and the South of Suffolk, the head of the estuary which thus opened out to the Red Crag Sea being somewhere near Norwich, and was separated from the Norwich Crag by a ridge of Coralline Crag, an instance having been found of the beds in contact. Between the head of the estuary at Norwich and the Red Crag district, several exposures of the Fluvio-marine crag occurred, as for instance in the neighbourhood of Halesworth and at Alborough, near which place it was stopped by the Coralline Crag. The land subsiding to a greater extent, the estuary became an arm of the sea, and the water then extended as far as, or perhaps beyond, Horstead, because the Crag that occurred there contained Fluvio-marine shells. The Chillesford Crag and Clay seem to have overlapped the Norwich Crag. Above them come a series of beds which Mr. Searles Wood, Jun., and the author, termed the pebble beds, which are in some places fossiliferous. These pebble beds seem to have eroded, and occasionally destroyed the Chillesford Clay. In some places near Norwich they are from 40 to 50 feet thick.

A careful examination of the Crag in the Bure Valley, exposed at Horstead, Coltishall, and Burgh, has led Mr. Searles V. Wood, Sen., to the conclusion that we have in that deposit a more Fluvio-marine form of the Chillesford Shell-bed, which is now generally held to include, besides the deposits of that place, the Crags of Aldeby, of Easton Cliff, and the Upper Bed at Thorpe and Bramerton; the depression which introduced the Chillesford beds, and covered the Norwich or Fluvio-marine Crag at Thorpe and Bramerton with a deposit containing exclusively marine shells, having thus carried the head of this ancient estuary further north—from Norwich to near Aylsham.

More than twelve months ago, Mr. Gunn called the author's attention to the section at Belaugh (mentioned by Mr. Samuel Woodward in his "Geology of Norfolk"), a mile distant from Horstead and Coltishall; and since then, having found that it presented such a different aspect, palæontologically, to the Norwich and Chillesford Crags, and such a resemblance to that of Weybourne, which extends along the base of the cliffs near Cromer, Mr. Wood, sen., has sifted a large quantity of material obtained from Belaugh, and the result proves it to belong to the newer deposit; and, with this conclusion, the stratigraphical evidence seems completely to concur.

Mr. S. V. Wood, Jun., has for some years maintained that the Crag at Weybourne (full of *Tellina solidula*) had no identity with the Norwich Crag. As this bed is often referred to by geologists as identical with the Norwich Crag, the author felt it important that the matter should be thoroughly investigated, and, the cause of confusion to all, and of error to one side or the other, removed.

The shells obtained from Belaugh and Weybourne, and identified by Mr. S. V. Wood, Sen., are as follows:—

Mytilus edulis.
Tellina solidula (or *Balthica*).
Tellina lata (or *calcarea*).
Tellina obliqua.
Donax anatinus.
Cyprina Islandica.
Scrobicularia piperata.
Leda limatula.
Cardium edule.
Cardium Grœnlandicum.
Macta ovata.
Mya truncata.
Mya arenaria.
Saxicava rugosa.
Pholas crispata.
Corbula nucleus.
Scalaria Grœnlandica.
Purpura crispata.
Littorina littorea.
Littorina rudis.
Natica catena.
Natica helicoides.
Pinna (probably *pectinata*), and a *Balanus.*

To these have since been added:—

Nucula Cobboldiæ.
Astarte borealis.
Astarte compressa.
Tellina prætenuis (very rare).
Lucina borealis.
Anomia striata.
Anatina phaseolina.
Fusus striatus and
Trophon antiquum, both dextral and sinistral varieties.

The important peculiarity of this fauna is the profusion, both at Belaugh and Weybourne, of the *Tellina solidula*, which does not exist either in the Norwich or Chillesford Crag. This shell, which is now extremely common on our coasts, and in the higher latitudes throughout the whole Northern Hemisphere, literally swarms in these beds, as it always does wherever it is found; a handful of shells gathered at random either on Yarmouth beach, or in the Weybourne or Belaugh bed, consisting principally of it. It is also found throughout the whole Glacial Series, being common to the Till, the contorted drift, the middle Glacial sands, and the upper Glacial deposits at Bridlington. It also occurs in the Post-glacial deposits of the Nar Valley and of Kelsea Hill, in Yorkshire. Its first occurrence seems to mark a well-defined geological horizon, and it is that which Mr. Wood has adopted, as dividing the Glacial series from the Crag; the lower Glacial beginning with the Belaugh and Weybourne beds.

All the rest of the shells found (with the exception of a univalve, not yet identified.) are forms occurring in the Crag, but they consist *principally* of the more boreal forms of the Crag Mollusca, some truly arctic shells occurring in great profusion, no instance existing elsewhere in the Crag series of such a profusion of *Astarte borealis* as occurs at the base of the Belaugh deposit, which is literally paved with these shells.

Stratigraphically also these beds differ from those at Horstead, Coltishall, and Burgh. The strata resting on the Chalk at those places are as follows, in descending order:—

(D.) Red sand with pebbles. (C.) Laminated micaceous sands and clays (the Chillesford Clay). (B.) Fine whitish quartzose sands. (A.) Chalk.

The shells at Horstead, Coltishall. and Burgh are found in the bed (B) within a few feet of the Chalk, overlaid by the Chillesford Clay (C).

At Belaugh, on the contrary, the bed which contains the *Tellina solidula* is not in these white sands, but in the red pebble beds (D), which at Horstead, Coltishall, and Burgh overlie the Chillesford Clay; and the shell-bed is from 10 to 15 feet distant from the surface of the Chalk, as determined by Mr. Gunn and the author, by sinking a hole down to the latter. These pebbly sands, which are a widespread deposit, appear, at this place, to have eroded the Chillesford Clay, and completely destroyed it. Mr. Wood and the author consider the thin irregular band of clay, at the base of the shell-bed at Belaugh, has been derived from the destruction of the Chillesford Clay hard by, during the formation of the slight trough in which the Belaugh sands repose; but although they think that this clay band does not represent any portion of the Chillesford Clay *in situ*, they feel no doubt that the shells at this place are in the bed (D), and not in the bed (B). At Weybourne the pebbly sands which contain the shells, and the base of which is called Crag, rest directly on the Chalk.

When sinking to the Chalk at Belaugh, a shell-bed (considerably lower than those exposed in the section in which the *Tellina solidula* occurs) was met with. This bed rested upon the thin clay-band before mentioned, and in it but very few specimens of *Tellina solidula* and *Littorina littorea* (so profuse in the upper part) could be detected, but it was almost exclusively composed of *Astarte borealis* in a continuous layer, with occasional valves of *Astarte compressa* and *Cyprina Islandica*, the shells forming a complete pavement to the fossiliferous pebbly gravels, and with the thin clay-band separating them from the bed (B).

The position of the Belaugh deposit relatively to the Chillesford Clay seen in section at Horstead and Coltishall, a mile on the west, and again at Hoveton, near Wroxham Bridge, a mile on the east side of it, appears to be that it occupies a shallow trough excavated between the two places.

The excavation of this trough appears to have entirely removed the Chillesford Clay at Belaugh, so as to leave the shelly deposit of that place resting upon the white sands which contain the Chillesford shell-bed (a bed which is extremely inconstant so far as the presence of fossils is concerned, although the sand itself is always constant), and the thin band of clay down to which Mr. Fisher dug, and which Messrs. Gunn and Harmer found in sinking to the Chalk. This band of clay, which forms the base of the Belaugh bed proper (*i.e.* of the trough thus excavated), was seen on a subsequent excavation, made by the Messrs. Wood and the author, to rest with an irregular line upon the white sands forming the bed (B).

The only doubt felt by Mr. Wood and himself in connexion with the beds of the Crag series in Norfolk is, whether or not the pebbly sands of Belaugh and Weybourne are identical with the pebbly sands and pebble beds which overlie the Chillesford Clay in the neighbourhood of Norwich, of Loddon, of Halesworth, and of Beccles, or whether they do not form a still later deposit. The identity of the pebbly sands containing *Tellina solidula* at Belaugh, with the similar sands which form the so-called Crag of Weybourne, is sufficiently clear, not only on palæontological, but also on physical evidence, as they may be traced from Belaugh up the valley of the Bure, some distance above Aylsham, and though they disappear under the contorted drift (the upper part of that valley not cutting down sufficiently to reach them), they re-appear beneath the Till all along the base of the Cromer coast-section. This series of pebble beds, however, contains a number of quartz and quartzite pebbles, which do not seem to be present, at least in any quantity, in the beds which rest on the Chillesford Clay further south; moreover, the fossiliferous pebble-bed at Ditchingham, near Bungay, which, by its position, seems to belong to the latter beds, has not yet yielded the characteristic shell, *Tellina solidula*: so that for the present they do not express any opinion on the identity of the pebble-beds in these two areas. He mentioned, however, that like the Belaugh bed between Wroxham Bridge and Horstead, the pebble-beds around Halesworth have in many parts destroyed the Chillesford Clay lying up against it, and resting on the Crag sands beneath. Where this is the case the pebble-beds are usually of great thickness (thirty feet and more), and beached up in the continuous slope of oblique bedding, that results from material being thrown subaerially into the angle of repose.

Since writing the above, several more sections have been met with, in which the *Tellina solidula* shell-bed occurs. One pointed out by Mr. Gunn, between Belaugh and Coltishall, one at Wroxham, and another at Rackheath. There is, probably, an exposure of it at Crostwick, though the author had not been able to find it, as there is in the Museum a specimen of this shell said to have been found at that place.

After some remarks from Mr. John E. Taylor, the Honorary Secretary, on the geographical range of *Astarte* and *Tellina*; and from Mr. Bayfield on the Iron-pan of Norfolk; the President said, the most important feature of Mr. Harmer's paper was that it controverted a statement made by Sir Charles Lyell, in his "Antiquity of Man," in which work, at p. 213, he represented the Norwich Crag extending and rising above the Chalk in the direction of Weybourne, whereas Mr. Searles Wood and Mr. Harmer had proved that this is quite erroneous, that if ever the Norwich Crag existed there, it had been denuded and replaced by a more recent bed containing *Tellina solidula* (or *Balthica*), which had never yet been found below the Chillesford Clay. They had a most perfect section along the coast. The same beds do not appear in all places, but their order is never inverted. He (Mr. Gunn) concurred with Mr. Harmer that the Chillesford Clay had been very much eroded in places, and much disturbed, particularly at Belaugh. It had been confounded with the banded laminated clay, which was very persistent, and formed a good horizon in relation to the Forest Bed and other deposits. The best section was to be seen at Aldeby, where they had, immediately above the Upper Norwich Crag, these banded laminated clays; then a bed of sand, some few inches thick, supporting the brown Chillesford Clays. He believed this matter was very important, for in the laminated clays they had occasionally the same shells as in the Upper Norwich Crag; whereas, in the pure brown Chillesford Clay, none had been found, and only the bones of a whale. This was important as indicating the increasing depth of the waters, and proved the arctic character of the beds.

Mr. Harmer, in replying, remarked that he had found the presence of mica to be an almost invariable criterion of the Chillesford clay.

The President then read a brief paper in reference to the statement made by sailors, etc., that the ruined church of Shipden was to be seen about half a mile out at sea off Cromer, or its foundations, still standing *in situ*. The absurdity of the idea does not strike one, unless it is borne in mind that the cliffs rose to a higher eminence than the present (nearly 200 feet), and that, therefore, it is quite impossible that the foundations of the Church can be standing at four fathoms depth beneath the level of the water. That fragments and large detached masses of walls are to be seen, in clear water, can scarcely be questioned, and Mr. Gunn had frequently seen masses of masonry, at low water, near the Cromer Jetty rolled down from the height at which the buildings stood upon the surface of the land. The President then referred to the Old Cromer Lighthouse, or Beacon, which disappeared in a landslip in 1865. The building was 50 feet in height, and of considerable circumference, but after searching amongst the *débris* of the landslip, and along the shore, there was not a vestige of it to be seen. It was the opinion of residents on the spot that it fell perpendicularly down, and was engulphed in the slip below. At the present time the *débris* is nearly washed away to the site of the Beacon, and, consequently, its remains, at least, ought to be detected at the foot of the cliff. The hardness of the beach forbids the idea that it could have buried itself beneath its level.

SUPPLEMENTARY NOTE TO PROF. OWEN'S PAPER ON *STROPHODUS MEDIUS* (pp. 193–6).

By the courtesy of Messrs. A. and C. Black, of Edinburgh, we are enabled to add a figure of the lower jaw and teeth of *Cestracion Philippi*, 'the Port Jackson Shark,'[1] (half natural size); the recent type referred to in Prof. Owen's paper as elucidating the characters of the dentition of *Strophodus*.

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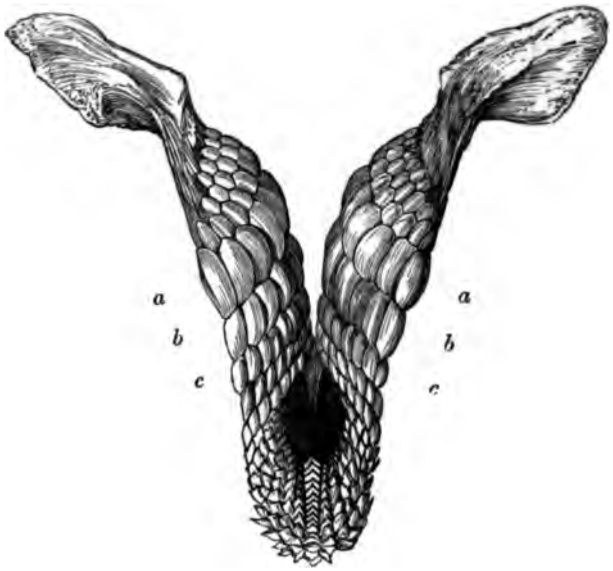
[1] *Copy of Cut 41, p. 127 of* "Owen's Palæontology," 1861, 2nd edition.

The block unfortunately arrived too late for insertion in its proper place in the article.—Edit.



Lower jaw and teeth of *Cestracion Philippi*, half natural size. The letters indicate the corresponding rows of teeth seen in *Strophodus medius*, Owen; figured in Plate VII. herewith. (See Prof. Owen's article, p. 193.)

CORRESPONDENCE.

GEOLOGICAL NOTES ON NORTHAMPTONSHIRE, &c.

Sir,—I am glad to see that Professor Morris, in his recent Paper on the Oolites of the Midland Counties in the March number of the Geological Magazine, has confirmed an opinion I long ago maintained, that some of the beds which he describes in Lincolnshire and Northamptonshire belong rather to the Inferior than the Great Oolite, to which they have been hitherto referred by the Geological Surveyors, and with whom, if I remember right, Mr. Morris then agreed. He seems to have forgotten, or probably was not aware, that I had written a short paper on the geology of the neighbourhood of Grantham, for the Cotswold Club, in 1850, since printed in their Proceedings; and a short notice on the Inferior Oolite in parts of North Hants, in the Annals of Natural History in 1857. In these I stated, in effect, that, after a careful examination of the sections, and comparison of the fossils with those of the Cotswold area, with which I was familiar,[1] I had arrived at the conclusion that certain strata, immediately overlying the Lias to which he refers should be more properly assigned to the Inferior Oolite, and I added that they required a further and closer *examination*. I have visited most of the localities in Lincolnshire,

[1] *Proceedings* of the Geol. Soc., 1850, vol. vi. pt. 1 and 1851.

Gloucestershire, and Northamptonshire mentioned in his interesting paper, and I obtained many of the fossils given in his list. Several of these from the neighbourhood of Grantham I sent, at the time, to my friend Dr. Lycett, and he stated that although the greater number were new to him yet the rest were species decidedly belonging to the Inferior Oolite; and Mr. Sharp, with whom, on a future occasion, I examined the neighbourhood of Northampton, and who is thoroughly conversant with the geology of the district, agreed with me in classing the ferruginous Oolite overlying the Lias with the Inferior Oolite. Amongst other fossils obtained there of a decidedly Inferior Oolite facies I found a specimen of *Pygaster semisulcatus* which has not yet been recorded higher than that formation, and is common enough in the peagrit and pisolite near Cheltenham. Mr. Morris gives it in his list of fossils near Northampton, as well as *Hyboclypus agariciformis.* If these were not considered sufficient to prove the position of the rock in which they occur, the other shells I obtained associated with them, and a still larger number named by Mr. Morris, are decisive upon the point, as far as palæontological evidence goes. As there is also a clear ascending section from the Lias to the Great Oolite, the intervening strata may, therefore, be more reasonably placed with the Inferior Oolite, although there are certain lithological differences and a large increase of ferruginous matter in the Midland district, when compared with the same formation in Gloucestershire. It is not a matter of much consequence, but I think it due to myself to state that, after a careful comparison of the sections and fossils of the outer escarpments of the Cotswolds with those of Lincolnshire, and Northamptonshire, I had held from the first, since the year 1850, that a certain portion of the Oolites of the Midland Counties belonged to the Inferior Oolite, with which they will now probably be again and finally classed.

P. B. BRODIE.

VICARAGE, ROWINGTON, WARWICK.
March 17, 1869

ELEPHAS MERIDIONALIS IN THE NORWICH CRAG.

Sir,—I was surprised on again seeing Mr. Roper's collection at Lowestoff, to find that it did not contain one single specimen of an elephant's tooth, and that all the Mammalian remains were from, as he described it, the Coprolite bed beneath the Coralline Crag, and none at all from the Red Crag. The collection had been removed from West Tofts, near Brandon, where I had seen it five years ago; but there was no ground to suppose any specimen had been lost, for Mr. Roper showed me a MS., in which he had carefully figured all the mammals, with a coloured section of the strata at Sutton. The lowest of these was the bed from which he had taken an old shed tooth of a Mastodon, and three fragmentary portions of others, together with the basal part of a deer's horn, and a beautiful and perfect molar of a pig. Above this was the Coralline Crag, and then the Red Crag, from which, he said, he had obtained no Mammalian remains whatever.

I am very sorry to have misled Mr. Fisher by my having confounded, as it appears, I must have done, this tooth of a Mastodon, in which the mammillæ are worn down, with one of the *Elephas meridionalis*; at the same time I am glad to have been the means of calling attention to this singular coincidence with the discovery made by Mr. Prestwich, of similar mammalian remains in the stone-bed beneath the Coralline Crag at Sutton.

As Mr. Lankester wishes "to see a list of mammalian remains, in addition to the Mastodon teeth found in Mr. Gunn's stone-bed," in part performance—and because I cannot, after what has passed, expect him to receive my account—I will send to the Geological Society's rooms for his inspection an old shed tooth of the *E. meridionalis*, which I obtained last Monday, when in company with Sir C. Lyell and Mr. Leonard Lyell at the Horstead marl-pit, from the stony bed. Besides this, I had obtained previously three fine specimens of molars of the *E. meridionalis* from the Horstead and Coltishall pits, from the same bed, and another not referable to any recognised species of elephant, and three basal portions of the horns of deer (not described), and no other mammalian remains, except the Mastodon.

With reference to this stone-bed, I beg to be allowed to add some observations which I have made. It appears to lie upon an old land surface of the Chalk, which dips on an average 29 feet in the mile. This land surface seems to have been subaërial, in part at least during the successive deposits of the Tertiary beds, until it was entirely submerged in the Glacial period; and the animals, which lived upon it were entombed in or beneath the stony-bed. It is a well ascertained fact that the remains of the Mastodon are found immediately upon the Chalk or in the disturbed chalk-rubble, while those of the elephant and deer are found among the stones derived from the disintegrated Chalk. It appears to me, therefore, that this stony-bed admits of sub-division, and that a long period of time may have intervened between the deposition of the Mastodon and Elephant remains, and that no evidence is afforded of the co-existence of these two proboscideans in this locality.

Upon this stone-bed, on the land going down, or the water rising, whichever it might be, the fluvio-marine Crag was deposited, which is, according to my experience, nearly non-mammaliferous; and on this ground I ventured to suggest that the stone-bed and the fluvio-marine Crag, which have hitherto been considered one, and named by Mr. Charlesworth Mammaliferous Crag, should be separated. It is difficult to make the above clear without the aid of a diagram, and I propose to submit one, together with fuller details relative to the order of succession of these and the associated beds, to the Geological Society.

I have to thank Mr. Fisher for the answer he has given relative to the gravel on the south bank at Lopham ford. It is a matter of opinion as to whether it is middle-drift gravel or valley gravel. I visited the spot with Mr. Prestwich and Mr. Flower, and they both remarked that the gravel bore a striking resemblance to that of St. Acheul.

JOHN GUNN.

IRSTEAD RECTORY, BY NORWICH.

AGE OF THE ROCKS OF ALASKA TERRITORY.

Sir,—Mr. Dall appears to me, in the extract of a letter of his, published in your last number, to base his determination of the Alaska beds upon a species of *Platanus* found near Topanica, which he conconsiders to be undoubtedly Miocene. I fear this cannot be accepted as settling the question, seeing that Professor Heer has described a species of this genus (*P. Newberryana*), from Nebraska, found in strata which he originally considered to be Miocene, but which Prof. Newberry has lately shown from the molluscan remains to be Cretaceous. Some additional evidence must be found before the age of these beds can be definitively fixed. The remarkable persistence of some of the generic forms of America from the Secondary down to the existing flora, as lately expounded by Professor Newberry, is a fact of great importance, especially when contrasted with the changes which have taken place in the Secondary and subsequent floras of Europe. W. Carruthers.

THE OLDEST BRITISH BELEMNITE.

Sir,—The interesting notice by Mr. Tate, of his "little old" Belemnite from the Lower Lias beds, which yield *Ammonites angulatus*, may be a fit occasion for entreating the renewed attention of Palæontologists to the importance of this kind of research, unpromising though it be, for the origin of the "geno." My friend, Mr. C. Moore, besides placing at my disposal his whole collection of Belemnites, has sent me, among other rarities, a very small conical specimen from beds immediately above those which yield *Ostrea liassica*. This may be the young of the short conical form to which I have given the name of *Belemnites calcar* (Monograph of *Belemnitidæ*, pl. 11, fig. 4). The fossil described by Mr. Tate must certainly be distinguished from every variety of *Belemnites clavatus*; regarded as a young individual, it may with some confidence be thought likely to prove to be closely allied to *B. pencillatus*, which is by no means always deprived of lateral furrows, and is, in fact, a variable species (Monograph of *Belemnitidæ*, pl. 1., fig. 2, p. 35). I possess specimens of *B. acutus* and *B. pencillatus*, from the Lower Lias of Antrim. *Belemnites dorsalis*, of the Yorkshire Upper Lias, is certainly quite distinct. John Phillips.

Oxford, *April* 4, 1869.

THE OLDEST BRITISH BELEMNITE.

Sir,—Mr. Tate's "oldest British Belemnite," described in the April number of the Geological Magazine, will have to yield the palm to an older one, which I found some years ago in the Insect beds (*Ammonites planorbis* zone of some geologists) at Binton, in Warwickshire. My friend Professor Phillips supposed that no Belemnites were known so low down, and I at once forwarded the specimen to him, and it is still in his possession. Unfortunately it is a mere fragment, consisting only of the phragmocone or chambered part of the shell, without the attached guard or sheath. The chambers, though crushed, from their size, indicate a tolerably large

Belemnite, but the species, I presume, cannot be determined. This is the only specimen I have ever discovered or heard of in this division of the Lower Lias, and the genus appears to be very rare.

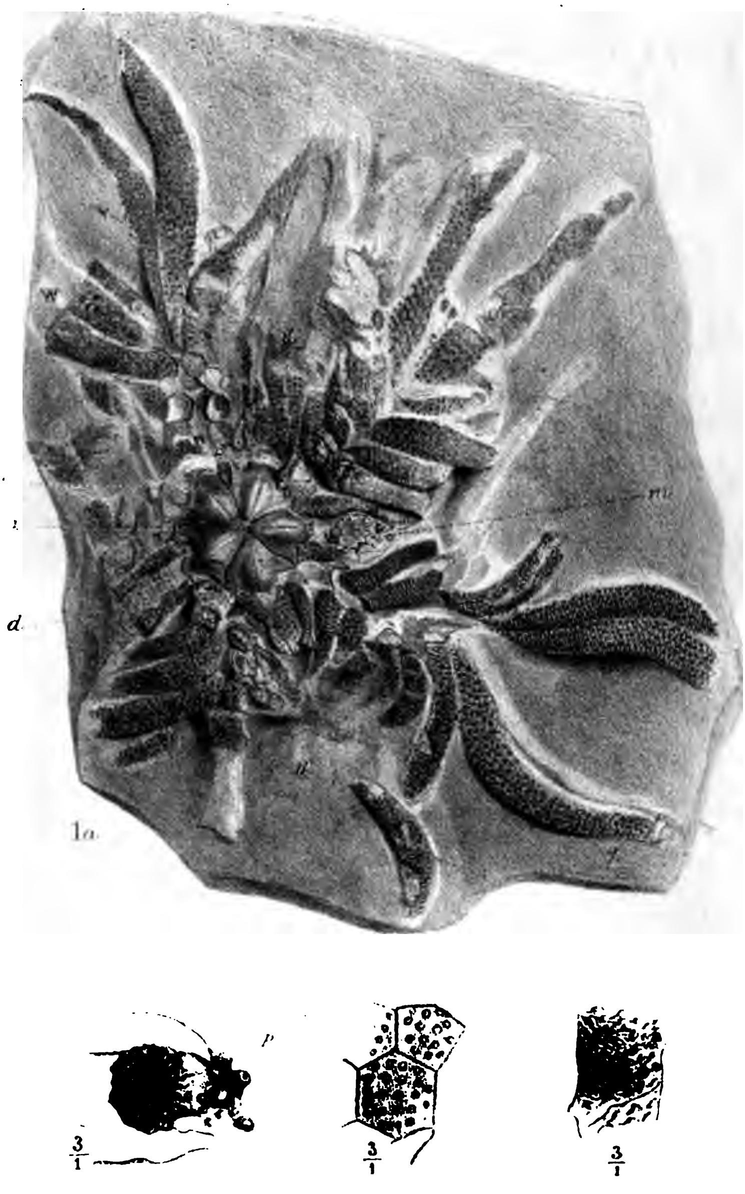
P. B. Brodie, M.A., F.G.S.

Vicarage, Rowington, Warwick.
April 15, 1869.

OBITUARY.

CHARLES ÆMILIUS OLDHAM, B.A.

Indian geology has sustained a great loss by the death of one of its most ardent labourers, Mr. Charles Æmilius Oldham, youngest son of the late Thomas Oldham, Esq., of Dublin, and brother of Dr. T. Oldham, Superintendent of the Geological Survey of India, which lately took place at Wellington Road, Dublin. The deceased entered Dublin University in 1846, where, having passed a very distinguished undergraduate course, and obtaining a classical sizarship and scholarship, he took the degree of B.A. as senior moderator and gold medallist in Ethics and Logic in 1852. He afterwards entered the School of Mines, Jermyn Street, London; and on the completion of his studies there, was appointed in 1856 on the staff of the Geological Survey of India. For several years past he acted as Deputy Superintendent of the Survey of the Madras Presidency; and during the last two years held the lectureship of Geology to the Engineering College of Madras. He married in 1863, Evelyn, second daughter of Professor W. King, of the Queen's Universities in Ireland. In the middle of last December, he returned home on leave of absence, in the enjoyment, to all appearance, of perfect health. Two months subsequent to his arrival, symptoms of approaching illness manifested themselves; and shortly after he became affected with blood-poison, consequent on the breaking off and decomposition of a Guinea-worm that had penetrated one of his legs while on duty. Passing through various phases, his illness, of a most painful character, terminated fatally on the 30th of March, in severe congestion and inflammation of the lungs. He died in the 38th year of his age. His name will ever be associated with the early progress of the Geological Survey of Southern India, as it is honourably connected, like those of his colleagues, with the discovery in the Madras Presidency of the quartzite implements that have attracted so much attention of late. Gifted with a most amiable disposition and talents of a high order, being in the prime of life, and having just entered on the necessary leisure by which, for the first time, he became enabled to communicate his knowledge of Indian geology to the scientific public, and leaving a widow, with one son, to mourn her irreparable loss, under such circumstances, the sudden and unexpected death of Mr. Oldham has spread intense grief among a wide circle of friends.



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Eucladia Johnsoni, H. Woodw.
U. Silurian, Dudley

THE
GEOLOGICAL MAGAZINE.

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ORIGINAL ARTICLES.

I.—GEMS FROM PRIVATE COLLECTIONS, No. 1.

ON *EUCLADIA*,[1] A NEW GENUS OF *OPHIURIDÆ*, FROM THE UPPER SILURIAN, DUDLEY.

By **HENRY WOODWARD**, F.G.S., F.Z.S., etc., of the Geological Department, British Museum.

(PLATE VIII.)

THE beautiful fossil Star-fish, which forms the subject of this paper, and is represented of the natural size upon the accompanying Plate VIII., is from the cabinet of Mr. Henry Johnson, of Dudley, the Honorary Secretary of the South Staffordshire and East Worcestershire Institute of Mining Engineers. It was obtained some years since in the shale between the Wenlock and Aymestry Limestones (probably Lower Ludlow shale), at Sedgley, near Dudley.

The specimen exhibits the ventral surface of the body of the animal, surrounded by five bifurcating arms, each furnished with five pairs of stout pinnæ, the first pair springing from near the commencement of the arm and being inserted close to the border of the petal-shaped pentagonal (oral) plate (Plate VIII., Fig. 1 *a.*, *c.*); each pair of pinnæ increasing in size in proportion as it recedes from the central disk, the pair nearest the mouth being the smallest.

The arms and pinnæ are nearly round in section, and taper gently towards their extremities; the surface of both is everywhere covered with minute imbricated plates, the projecting points of which give it an extremely scabrous appearance (See Fig. 1*a* and 1*d*). On carefully removing a portion of one of the arms at the part marked *z*, the same rugose surface was exposed; the arm at this point had been compressed, apparently before it had become mineralized; other arms, as those for instance at the point *w*, displaying, where broken off, a nearly round section.

The pinnæ, which diverge obliquely outwards on either side from the point of their attachment to the arms, curve downwards at their extremities and are lost in the matrix upon which the specimen rests, nor can the arms themselves be traced quite to their extremities, the points being either buried in the matrix or broken off. One arm, originally springing from the point marked *x*, is only indicated by a

[1] From ευ beautiful, κλάδος branch.

fragment of its base and one of its first pair of pinnæ. On carefully examining the sides of the arms, where exposed, a few bases of broken off spines can be detected, indicating probably that the arms were originally spinous along their borders.

At the point *m*, Fig. 1 *a*., the madreporiform tubercle can be distinctly seen *in situ*, occupying the same relative position in the fossil which it does in all the living species of *Ophiuridæ*.

The centre of the body of the animal is marked by a rosette composed of five pairs of plates, forming a pentagonal figure, each pair being anchylosed together, and forming at the outer margin a rounded lobe—like the petal of a flower. Between each of these is inserted the base of one of the five arms articulated and united to the pentagonal plates by a pair of styliform processes given off from the external margin of each lobe (see *s*, Fig. 1 *a*).

The body appears to have been discoidal, and was probably of considerable thickness, but the hard stony matrix precludes the possibility of ascertaining its extent. We are able, nevertheless, to perceive between the arms several of the pentagonal and hexagonal plates, which formed the covering of the disk, still *in situ* (see *d, d, d*, Fig. 1 *a*, and Fig. 1 *c*), the surface of which is covered with minute tubercles, several of which near the madreporiform body are elevated into prominent papillæ (see *p*, Fig. 1 *b*).

From the position of the madreporiform tubercle (*m*) with regard to the central pentagonal plates (*c*, Fig. 1*a*), there is no reason to doubt that these are the true oral plates, and as additional evidence, it will be observed that the arms take their origin from the margin of the pentagonal rosette, and *overlie the body-disk*, as in all the living *Ophiuridæ*; the pinnæ also take their origin from the same surface of the arms; the pinnæ in the *Echinodermata* being invariably placed on the innermost border of the arms near the mouth.

After a careful examination of the bibliography of the class *Echinodermata*, and a comparison of the fossil under consideration with all those forms of recent and fossil star-fishes likely to aid me in my investigation, I have been led to refer it to the order *Ophiuridæ*. The members of this group are very distinct from the true star-fishes (*Asteriadæ*) on the one hand, and the *Crinoideæ* on the other.

"In fact," writes Prof. Edward Forbes,[1] "they hold the same relation to the *Crinoideæ* that the true star-fishes hold to the sea-urchins" (*Echinidæ*). "They are *Spinigrade* animals, and have no true suckers by which to walk, their progression being effected (and with great facility) by means of five long flexible-jointed processes, placed at regular distances round their body, and furnished with spines on the sides and membranous tentacula. These processes are very different from the arms of the true star-fishes, which are lobes of the animal's body; whereas the arms of the *Ophiuridæ* are superadded to the body, and there is no excavation in them for any prolongation of the digestive organs."

Of the families *Ophiuræ* and *Euryales*, included in this order, the former have simple arms, whilst those of the latter ramify into many processes.

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[1] "History of British Star-fishes," p. 19.

Although the fossil under consideration most nearly approaches *Euryalus*, it cannot be, with propriety, referred to that or any known genus of *Ophiuridæ*, recent or fossil. In *Euryalus* the five arms branch dichotomously from their roots with cirrhous extremities, but they are not furnished with pinnæ.

The interbrachial spaces in the body-disk of *Euryalus* are membranous, whilst in the fossil, as we have seen, they are protected with a covering of calcareous plates more nearly resembling, in this respect, the body-disk of *Ophiura*.

The addition of pinnæ to the arms, together with their bifurcated character offers an analogy to the *Crinoideæ*, thus aiding us in filling up another gap in the chain by which the forms that existed in Palæozoic times are linked to those of our own.

We have in this fossil presented to us a type of Palæozoic star-fishes extending its affinities towards the *Comatulæ* on the one hand and to *Ophiura* and *Euryalus* on the other; exemplifying what Professor Owen has so happily termed "a more generalized type of structure" than any at present existing in the class *Echinodermata*.

The same writer observes:—"As we advance in our survey of the organisation and metamorphoses of animals, we shall meet with many examples in which the embryonic forms and conditions of structure of existing species have, at former periods, been persistent and common, and represented by mature and procreative species."[1]

Having been informed that at a meeting of the Dudley and Midland Geological and Scientific Society (held some years since) Mr. J. W. Salter suggested that this specimen should be named *Eucladia Johnsoni*, I have great pleasure in carrying his suggestion into effect.

The star-fish rests upon a slab covered with numerous small Brachiopods (*Rhynchonella borealis?*), fragments of Trilobites, Crinoids, etc., presenting the appearance of having been quietly washed on shore, mouth uppermost, and being unable to right itself, it had been left to die, and finally to become imbedded in the superimposed sediments, a fossil of rare beauty, and a happy "find" for the Dudley collector.

Dimensions of *Eucladia Johnsoni*:—Diameter of pentagonal plates, eight lines; diameter of disk, two inches; diameter of madrepori-form body, two lines; greatest length of arm preserved, 2½ inches. From centre of disk to bifurcation of arms, 1½ inches.

[It was with no small satisfaction that, in turning over some MSS. of my late brother, Dr. S. P. Woodward, I met with an admirable photograph of this fossil (taken in 1863, by the late L. P. Capewell, Esq., of Dudley), bearing the following memorandum in his own hand-writing:—"*Euryalus?* Wenlock Limestone, Dudley (Mr. Henry Johnson, Mining Engineer, Dudley). Arms five, about five inches long, covered with strong tubercles, central plates, five pairs, madreporiform tubercle. Photographed by Mr. Capewell."]

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[1] Lecture X. *Echinoderma*, p. 129. "Comparative Anatomy and Physiology of the Invertebrata." By *Prof. Owen. 1843.*

The following is a list of the known genera and species of fossil star-fishes (*Asteriadæ* and *Ophiuridæ*), from the Silurian rocks, with a reference to their authorities, formation, and locality :—

I. *Edrioaster Bigsbyi*, Billings, Trenton L. Ottawa City, Canada West.
II. *Eugaster Logani*, Hall, 1866. Twentieth Report on the State Cabinet, New York, p. 10, pl. 9, fig. 7. Hamilton Group, Madison County, New York.
III. 1. *Glyptaster brachiatus*, Hall, Silurian (several stages), New York.
2. „ *inornatus*, Hall, Niagara Group, Indiana.
3. „ *occidentalis*, Hall, „ „
4. „ *pentangularis*, Hall, „ „
IV. *Lepidaster Grayi*, Forbes, Memoirs Geol. Surv., Dec. 3. 1850. U. Silurian, Dudley.
V. 1. *Palæaster asperrima*, Salter, 1857. Ann. and Mag. Nat. Hist. 2nd series, Vol. xx. p. 325, pl. ix. fig. 1. Caradoc, or Bala Sandstones, near Welchpool, N. Wales.
2. „ (*Uraster*) *obtusa*, Forbes. Mem. Geol. Surv., 1849. Decade 1, pl. i, fig. 3. Caradoc, Drumcannon Waterford Bala Rocks, Moel-y–Garnedd.
3. „ *coronella*. Salter. 1857. Ann. and Mag. Nat. Hist. op. cit. p. 326. May Hill Sandstone. Malvern.
4. „ (*Uraster*) *Ruthveni*, Forbes. 1849, op. cit. Decade 1, pl. i. fig. 1. Ludlow Rocks, Kendal, Westmoreland.
5. „ *hirudo*, Forbes, 1849, loc. cit. pl. i. fig. 4. Ludlow Rocks, Kendal, Westmoreland.
6. „ *Niagarensis*, Hall, Palæontology of New York. Trenton Limestone. New York.
7. „ (*Asterias*) *matutina*, Hall, Palæontology, New York. Vol. i. p. 91, pl. xxix. fig. 5. Twentieth Report of State Cabinet, 1866. p. 3, pl. ix. fig. 2 (syn. *Petraster rigidus*). Trenton Limestone. Trenton Falls.
8. „ *Palæaster Shæfferi*, Hall; 20th Report, 1866, p. 4, pl. ix. fig. 1. Shales of Hudson River Group, Cincinnati, Ohio.
9. „ *granulosa*, Hall; 20th Report, 1866, p. 5. Same formation as last species.
10. „ (*Petraster*) *Wilberanus*, Meek and Worthen. Proceeds. Acad. Nat. Soc., Philadelphia, 1861, p. 142; Hall, 20th Report, 1866, p. 5. Lr. Silurian, Oswego, Kendall Co. Illinois.
11. „ (*Asterias*) *antiquata*, Locke, Proceeds. Acad. Nat. Soc., Philadelphia, 1846, vol. iii. p. 32. Hudson's River Group. Cincinnati.
12. „ *Jamesii*, Dana, sp. U. P. James, Acad. Nat. Soc., 1841. American Journ. Soc., vol. i. p. 441. Dana, American Journ. Soc. (n. s.), vol. 35. p. 295. Hudson's River Group, Cincinnati.
13. „ *antiqua*, Troost, sp. 1835. Hall, 20th Report on State Cabinet, 1866, p. 7. Hudson's River Group, Harpeth River, Davidson County. Tennesse.
14. „ *eucharis*, Hall. 20th Report, 1866, p. 7, pl. ix. fig. 3. Hamilton Group, Hamilton, Madison Co., etc., etc.
15. „ *constellata*, Thorent, Lower Green Schists, Lower Silurian, Mondrepuis, Aisné, France.
16. „ *imbricata*, Salter. n. sp. Caradoc. Llanfyllin, Montgomeryshire, Wales.
17. „ *parviuscula*. Billings, Clinton Group, Arisaig, Nova Scotia.
18. „ *pygmæa*, Eichwald, Lower Silurian, Pulkowa, Russia.
VI. 1. *Palasterina antiqua*, Hisinger, Lethæa Suecia, p. 89, t. 26, fig. 6. Ludlow Rocks, Mount Hoburg, Sweden; and Hudson River Group, Cincinnati, Ohio.
2. „ (*Uraster*) *primæva*, Forbes, 1849, op. cit. pl. 1, fig. 2. Salter, 1857. op. cit. p. 327, pl. ix. fig. 2 Ludlow Rocks, Underbarrow, Westmoreland; and Leintwardine, Shropshire.
3. „ *stellata*, Billings, Geol. Surv., Canada. Org. Rem. Decade iii. pl. ix. fig 1, p. 76. Trenton Limestone, Ottawa City.
4. „ *rugosa*. Billings, ibid. pl. ix. fig. 2, p. 77. Hudson River Group, Anticosti.
5. „ *rigida*, Billings, Trenton Limestone, Ottawa City, Canada West.
VII. 1. Palæocoma Marstoni, Salter, 1857, op. cit. p. 328, pl. ix. fig. 3. Lower Ludlow, Church Hill, Leintwardine.

2. *Palæcoma Colvini*, Salter, op. cit. p. 328 (loc. same as foregoing sp.).
3. „ *cygnipes*, Salter. op. cit. p. 329 „ „
4. „ (*Bdellacoma*) *vermiformis*, Salter, op. cit. p. 329 (loc. ibid.).
5. „ (*Rhopalocoma*) *pyrotechnica*. Salter, op. cit. ditto.
6. „ *spinosa*, Billings, Trenton Limestone. Montmorency Falls, Canada East.

VIII. *Palæodiscus ferox*, Salter, 1857, op. cit. p. 333, pl. ix. fig. 6. Lower Ludlow Rock, Leintwardine.

IX. *Petraster bellulus*, Troost, Niagara Group, Grimsby, Canada West.

X. 1. *Protaster Miltoni*, Salter, 1857. op. cit. pl. ix. fig. 4. Lower Ludlow, Leintwardine, etc.
2. „ *leptosoma*, Salter, 1857, op. cit. pl. ix. fig. 5 (locality ibid.).
3. „ *Sedgwickii*, Forbes, 1849, Mem. Geol. Surv. Decade i. pl. iv. Ludlow Rocks, Underbarrow, Kendal, Westmoreland.
4. „ *Salteri*, Sowerby, 1845, Quart. Journ. Geol. Soc., vol. i. p. 20. Lower Silurian Cerrig-y-Druidion.
5. „ *Forbesi*, Hall, Upper Silurian, Herkimer Co., New York.

XI. *Ptilonaster princeps*, Hall, 1866. 20th Report, p. 12, pl. ix. fig 9. Chemung Group, Cortlandville.

XII. 1. *Stenaster Salteri*, Billings. Geol. Surv., Canada, Org. Rems. Decade iii. p. 78, pl. x. fig. 1. Trenton Limestone. Belville. Canada West.
2. „ *Huxleyi*, Billings, Quebec Group, Lower Silurian, Newfoundland.

XIII. 1. *Tæniaster spinosus*, Billings, Canadian Organic Remains, Decade iii., pl. x., fig. 3, p. 81. Trenton Limestone; Falls of Montmorency.
2. „ *cylindricus*, Billings, op. cit. pl. x., fig. 4, p. 81. Trenton Limestone, Ottawa City.

XIV. *Urasterella* (*Stenaster*) *pulchella*, Billings, sp. Geol. Surv. Canada, Report 1856, p. 292. Hall, 20th Report on State Cabinet, 1866, p. 9. Trenton Limestone, Ottawa City, Canada West.

Giving a total of 14 genera and 49 species of Silurian Star-fishes, 18 of which are British and the others (with three exceptions only) are North American.

EXPLANATION OF PLATE VIII.

Fig. 1 *a*. *Eucladia Johnsoni*, sp. nov. Upper Silurian, Sedgley, near Dudley. Drawn from the original specimen in the Cabinet of Henry Johnson, Esq., Dudley (natural size).
„ 1 *b*. The Madreporiform plate enlarged three times natural size.
„ 1 *c*. Three of the body-plates „ „ „ „ „
„ 1 *d*. Part of one of the arms „ „ „ „ „

II.—On the Probable Seat of Volcanic Action.

By T. Sterry Hunt, LL.D., F.R.S.

THE igneous theory of the earth's crust, which supposes it to have been at one time a fused mass, and to still retain in its interior a great degree of heat, is now generally admitted. In order to explain the origin of eruptive rocks, the phenomena of volcanos, and the movements of the earth's crust, all of which are conceived by geologists to depend upon the internal heat of the earth, three principal hypotheses have been put forward. Of these the first supposes that in the cooling of the globe a solid crust of no great thickness was formed, which rests upon the still uncongealed nucleus. The second hypothesis, maintained by Hopkins and by Poulett Scrope, supposes solidification to have commenced at the centre of the liquid globe, and to have advanced towards the circumference. Before the last portions became solidified, there was produced, it is conceived, a condition of imperfect liquidity, preventing the sinking of the cooled and heavier particles, and giving rise to a superficial crust, from which solidification would proceed downwards. There would thus be enclosed, between the inner and outer solid parts, a portion of uncongealed matter, which, according to Hopkins, may be supposed still to retain its liquid condition, and to be the seat of volcanic action, whether existing in isolated reservoirs or subterranean lakes; or whether, as suggested by Scrope, forming a continuous sheet surrounding the solid nucleus, whose existence is thus conciliated with the evident facts of a flexible crust, and of liquid ignited matters beneath.

Hopkins, in the discussion of this question, insisted upon the fact, established by his experiments, that pressure favors the solidification of matter, which, like rocks, pass in melting to a less dense condition, and hence concludes that the pressure existing at great depths must have induced solidification of the molten mass, at a temperature at which, under a less pressure, it would have remained liquid. Mr. Scrope has followed this up by the ingenious suggestion that the great pressure upon parts of the solid igneous mass may become relaxed from the effect of local movements of the earth's crust, causing portions of the solidified matter to pass immediately into the liquid state, thus giving rise to eruptive rocks in regions where all before was solid.[1]

Similar views have been put forward in a note by Rev. O. Fisher, and in an essay on the formation of mountain chains, by Mr. N. S. Shaler, in the proceedings of the Boston Society of Natural History, both of which appear in the GEOLOGICAL MAGAZINE for November last. As summed up by Mr. Shaler, the second hypothesis supposes that the earth "consists of an immense solid nucleus, a hardened outer crust, and an intermediate region of comparatively slight depth, in an imperfect state of igneous fusion." In this connection it is curious to remark that, as pointed out by Mr. J. Clifton Ward, in the same Magazine for December (page 581), Halley was led, from the study of terrestrial magnetism, to a similar hypothesis. He supposed the existence of two magnetic poles situated in the earth's outer crust, and two others in an interior mass, separated from the solid envelope by a fluid medium, and revolving, by a very small degree, slower than the outer crust.[2] The same conclusion was subsequently adopted by Hanstein.

The formation of a solid layer at the surface of the viscid and nearly congealed mass of the cooling globe, as supposed by the advocates of the second hypothesis, is readily admissible. That this process should commence when the remaining envelope of liquid was yet so deep that the refrigeration from that time to the present has not been sufficient for its entire solidification, is, however, not so probable. Such a crust on the cooling superficial layer would, from the contraction consequent on the further refrigeration of the liquid stratum beneath, become more or less depressed and corrugated, so that there would probably result, as I have elsewhere said, "an irregular diversified surface from the contraction of the congealing mass which at last formed a liquid bath of no great depth, surrounding the solid nucleus." Geological phenomena do not, however. in my opinion afford any evidence of the existence of yet unsolidified portions of the originally liquid material, but are more simply explained by the third hypothesis. This, like the last, supposes the existence of a solid nucleus, and of an outer crust, with an interposed layer of partially fluid matter, which is not, however, a still unsolidified portion of the once liquid globe, but consists of the outer part of the congealed primitive mass, disintegrated and modified by chemical and mechanical agencies, impregnated with water, and in a state of igneo-aqueous fusion.

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[1] See Scrope on Volcanos, and also his communication to the GEOLOGICAL MAGAZINE for Dec., 1868.

[2] The elevated temperature of the interior of the globe would probably offer no obstacle to the development of magnetism. In a recent experiment of M. Trève, communicated by M. Faye, to the French Academy of Sciences, it was found that molten cast iron when poured into a mould, surrounded by a helix which was traversed by an electric current, became a strong magnet when liquid at a temperature of 1300° C., and retained its magnetism while cooling (Comptes Rendus de l'Acad. des Sciences, Feb. 1869).

The history of this view forms an interesting chapter in geology. As remarked by Humboldt, a notion that volcanic phenomena have their seat in the sedimentary formations, and are dependent on the combustion of organic substances, belongs to the infancy of geology. To this period belong the notions of Lémary and Breislak (*Cosmos*, v. 443; Otte's translation). Keferstein in his *Naturgeschichte des Erdkörpers*, published in 1834, maintained that all crystalline non-stratified rocks from granite to lava, are products of the transformation of sedimentary strata, in part very recent, and that there is no well-defined line to be drawn between Neptunian and volcanic rocks, since they pass into each other. Volcanic phenomena, according to him, have their origin not in an igneous fluid centre, nor in an oxydizing metallic nucleus (Davy, Daubeny), but in known sedimentary formations, where they are the result of a peculiar kind of fermentation, which crystallizes and arranges in new forms the elements of the sedimentary strata, with an evolution of heat as a result of the chemical process (*Naturgeschichte*, vol. i. p. 109; also *Bull. Soc. Geol. de France* [1], vol. vii. p. 197). In commenting upon these views (*Am. Jour. Science*, July, 1860), I have remarked that, by ignoring the incandescent nucleus as a source of heat, Keferstein has excluded the true exciting cause of the chemical changes which take place in the buried sediments. The notion of a subterranean combustion or fermentation as a source of heat is to be rejected as irrational.

A view identical with that of Keferstein, as to the seat of volcanic phenomena, was soon after put forth by Sir John Herschel in a letter to Sir Charles Lyell in 1836 (*Proc. Geol. Soc. London*, ii. 548). Starting from the suggestion of Scrope and Babbage, that the isothermal horizons in the earth's crust must rise as a consequence of the accumulation of sediments, he insisted that deeply buried strata will thus become crystallized by heat, and may eventually, with their included water, be raised to the melting point, by which process gases would be generated, and earthquakes and volcanic eruptions follow. At the same time the mechanical disturbance of the equilibrium of pressure, consequent upon a transfer of sediments, while the yielding surface reposes on matters partly liquefied, will explain the movements of elevation and subsidence of the earth's crust. Herschel was probably ignorant of the extent to which his views had been anticipated by Keferstein; and the suggestions of the one and the other seemed to have passed unnoticed by geologists until, in March, 1858, I reproduced them in a paper read before the Canadian Institute (Toronto), being at that time acquainted with Herschel's letter, but not having met with the writings of Keferstein. I there considered the reaction which would take place under the influence of a high temperature in sediments permeated with water, and containing, besides silicious and aluminous matter, carbonates, sulphates, chloride, and carbonaceous substances. From these, it was shown, might be produced all the gaseous emanations of volcanic districts, while from aqueo-igneous fusion of the various *admixtures* might result the great variety of eruptive rocks. To quote the words of my paper just referred to: "We conceive that the earth's solid crust of anhydrous and primitive igneous rock is everywhere deeply concealed beneath its own ruins, which form a great mass of sedimentary strata, permeated by water. As heat from beneath invades these sediments, it produces in them that change which constitutes normal metamorphism. These rocks, at a sufficient depth, are necessarily in a state of igneo-aqueous fusion; and in the event of fracture in the overlying strata, may rise among them, taking the form of eruptive rocks. When the nature of the sediments is such as to generate great amounts of elastic fluids by their fusion, earthquakes and volcanic eruptions may result, and these—other things being equal—will be most likely to occur under the more recent formation." (*Canadian Journal*, May 1858, vol. iii. p. 207.)

The same views are insisted upon in a paper "On Some Points in Chemical Geology" (Quart. Jour. Geol. Soc., London, Nov. 1859, vol. xv. page 594), and have since been repeatedly put forward by me with farther explanations as to what I have designated above *the ruins of the crust of anhydrous and primitive igneous rock*. This, it is conceived, must, by contraction in cooling, have become porous and permeable, for a considerable depth, to the waters afterwards precipitated upon its surface. In this way it was prepared alike for mechanical disintegration, and for the chemical action of the acids, which, as shown in the two papers just referred to, must have been present in the air and the waters of the time. It is, moreover, not improbable that a yet unsolidified sheet of molten matter may then have existed beneath the earth's crust, and may have intervened in the volcanic phenomena of that early period, contributing by its extravasation to swell the vast amount of mineral matter then brought within aqueous and atmospheric influences. The earth, air, and water thus made to react upon each other, constitute the first matter from which by mechanical and chemical transformations the whole mineral world known to us has been produced.

It is the lower portions of this great disintegrated and water-*impregnated* mass which form, according to the present hypothesis, the semi-liquid layer supposed to intervene between the outer solid crust and the inner solid and anhydrous nucleus. In order to obtain a correct notion of the condition of this mass, both in earlier and later times, two points must be especially considered, the relation of temperature to depth, and that of solubility to pressure. It being conceded that the increase of temperature in descending in the earth's crust is due to the transmission and escape of heat from the interior, Mr. Hopkins showed mathematically that there exists a constant proportion between the effect of internal heat at the surface and the rate at which the temperature increases in descending. Thus, at the present time, while the mean temperature at the earth's surface is augmented only about one-twentieth of a degree Fahrenheit, by the escape of heat from below, the increase is to be found to be equal to about one degree for each sixty feet in depth. If, however, we go back to a period in the history of our globe when the heat passing upwards through its crust was sufficient to raise the superficial temperature twenty times as much as at present, that is to say, one degree of Fahrenheit, the augmentation of heat in descending would be twenty times as great as now, or one degree for each three feet in depth (Geol. Journal, viii. 59). The conclusion is inevitable that a condition of things must have existed during long periods in the history of the cooling globe when the accumulation of comparatively thin layers of sediment would have been sufficient to give rise to all the phenomena of metamorphism, vulcanicity, and movements of the crust, whose origin Herschel has so well explained.

Coming, in the next place, to consider the influence of pressure upon the buried materials derived from the mechanical and chemical disintegration of the primitive crust, we find that by the pressure of heated water throughout them, they are placed under conditions very unlike those of the original cooling mass. While pressure raises the fusing point of such bodies as expand in passing into the liquid state, it depresses that point for those which like ice contract in becoming liquid. The same principle extends to that liquefaction which constitutes solution; where, as is with few exceptions the case, the process is attended with condensation or diminution of volume, pressure will, as shown by the experiments of Sorby, augment the solvent power of the liquid,[1] under the influence of the elevated temperature, and the great pressure which prevail at considerable depths. Sediments should, therefore, by the effect of the water which they contain, acquire a certain degree of liquidity, rendering not improbable the suggestion of Scheerer, that the presence of five or ten per cent. of water may suffice, at temperatures approaching redness, to give to a granitic mass a liquidity partaking at once of the character of an igneous and an aqueous fusion. The studies by Mr. Sorby of the cavities in crystals have led him to conclude that the constituents of granitic and trachytic rocks have crystallized in the presence of liquid water, under great pressure, at temperatures not above redness, and consequently very far below that required for simple igneous fusion. The intervention of water in giving liquidity to lavas, has, in fact, long been taught by Scrope, and, notwithstanding the opposition of Plutonists like Durocher, Fournet, and Rivière, is now very generally admitted. In this connection, the reader is referred to the GEOLOGICAL MAGAZINE for February, 1868, page 57, where the history of this question is discussed.

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[1] Sorby, Bakerian Lecture, Royal Society, 1863.

It may here be remarked that if we regard the liquefaction of heated rocks under great pressure, and in presence of water, as a process of solution rather than of fusion, it would follow that diminution of pressure, as supposed by Mr. Scrope, would cause not liquefaction but the reverse. The mechanical pressure of great accumulations of sediment is to be regarded as co-operating with heat to augment the solvent action of the water, and as being thus one of the efficient causes of the liquefaction of deeply buried sedimentary rocks.

That water intervenes not only in the phenomena of volcanic eruptions, but in the crystallization of the minerals of eruptive rocks, which have been formed at temperatures far below that of igneous fusion, is a fact not easily reconciled with either the first or the second hypothesis of volcanic action, but is in perfect accordance with the one here maintained, which is also strongly supported by the study of the chemical composition of igneous rocks. These are generally referred to two great divisions, corresponding to what have been designated the trachytic and pyroxenic types, and to account for their origin, a separation of a liquid igneous mass beneath the earth's crust into two layers of acid and basic silicates, was imagined by Phillips, Durocher, and Bunsen. The latter, as is well known, has calculated the normal composition of these supposed trachytic and pyroxenic magmas, and conceives that from them, either separately, or by admixture, the various eruptive rocks are derived; so that the amounts of alumina, lime, magnesia, and alkalies, sustain a constant relation to the silica in the rock. If, however, we examine the analyses of the eruptive rocks of Hungary and Armenia made by Streng, and put forward in support of this view, there will be found such discrepancies between the actual and the calculated results as to throw grave doubts on Bunsen's hypothesis.

Two things become apparent from a study of the chemical nature of eruptive rocks; first, that their composition presents such variations as are irreconcilable with the simple origin generally assigned to them, and second, that it is similar to that of sedimentary rocks whose history and origin it is, in most cases, not difficult to trace. I have elsewhere pointed out how the natural operation of mechanical and chemical agencies tends to produce among sediments, a separation into two classes, corresponding to the two great divisions above noticed. From the mode of their accumulation, however, great variations must exist in the composition of the sediments corresponding to many of the varieties presented by eruptive rocks. The careful study of stratified rocks of aqueous origin discloses, in addition to these, the existence of deposits of basic silicates of peculiar types. Some of these are in great part magnesian, others consist of compounds like anorthite and labradorite, highly aluminous basic silicates, in which lime and soda enter to the almost complete exclusion of magnesia and other bases; while in the masses of pinite or agalmatolite rock, we have a similar aluminous silicate, in which lime and magnesia are wanting, and potash is the predominant alkali. In such sediments as these just enumerated, we find the representatives of eruptive rocks like peridotite, phonolite, leucitophyre, and similar rocks which are so many exceptions in the basic group of Bunsen. As, however, they are represented in the sediments of the earth's crust, their appearance as exotic rocks, consequent upon a softening and extravasation of the more easily liquefiable strata of deeply buried formations, is readily and simply explained.[1]

The object of the present communication has been to call the attention of geologists to the neglected views of Keferstein and Herschel, which I have endeavoured to extend and to adapt to the present state of our knowledge. It is proposed in another paper to consider the question of the agencies which have regulated the geographical distribution of volcanic phenomena both in ancient and in modern times.

Montreal, Canada, March, 1869.

III.—NOTES ON CONTINENTAL GEOLOGY AND PALÆONTOLOGY.

By THOMAS DAVIDSON, F.R.S., F.G.S.

(*Continued from p.* 205).

(PART III.)

DURING my recent stay at Geneva the eminent geologists MM. F. J. Pictet and P. de Loriol showed me a very considerable number of fossils, which they had collected from the middle and lower portions of the Cretaceous system of Switzerland and Savoy, and carefully explained the position of the beds from which they had been obtained. M. Pictet subsequently, at my request, recorded in manuscript his most recent views in connection with this important topic, of which I will shortly reproduce a translation for the benefit of the readers of the GEOLOGICAL MAGAZINE. He has, however, restricted his table and explanations to the middle and lower portions of the Cretaceous system, because the regions which surround Geneva do not exhibit any representatives or evidence in connection with the upper stages. M. Pictet has also explained his views with reference to the rock which, at the Porte-de-France, contains the *Terebratula janitor*, and of the Carpathian or Stramberg limestone, which has been placed by M. Hébert at the base of the Cretaceous system, but which others have referred to the Jurassic epoch. The correct determination of the true age of these rocks is a subject of very great importance, since they contain a rich assemblage of species bearing a particular and well-marked stamp, as may be seen by a glance at Professor Suess's admirable monograph, "Die Brachiopoden der Stramberger *Schichten*," as well as at those by Zettel, etc., on other classes.

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[1] See in this connection the *Canadian Journal*, for 1858, p. 203; Quart. Jour. Geol. Society for 1859, p. 494; Amer. Jour. Science [2] xxxvii., 255, xxxviii. 182; also Geology of Canada, 1863, pp. 643, 669, and Rep. Geol. Canada, 1866, p. 230.

In connection with this subject of the difficult classification of the rocks above mentioned, M. Lory, a distinguished French geologist, favourably known on account of his able researches in the geology of the French Alps, etc., has kindly transmitted to me a summary of his recent labours which he communicated on the 3rd of May to the Geological Society of France, and of which I now offer a translation prior to introducing M. Pictet's valuable observations upon the same subject. I have, moreover, considered it absolutely necessary to introduce the discussion in connection with the *T. viator* limestone of the Port-de-France and that of Stramberg, as they are so intimately connected with the fossils to be assigned to the Cretaceous period.

COMPARATIVE SEQUENCE FROM THE GAULT TO THE OXFORD CLAY.

By M. C. LORY. 29th April.

Region of the Central Jura.	*Subalpine Region.*
(Type situated between Besançon and Neufchatel.)	(Type neighbourhood of Grenoble.)
GAULT.	GAULT.
Marls, with *Plicatula placunea.*	Aptien Marls, with *Belemn. semicanaliculatus*, etc.
Marls, with Orbitolines, *Salenia prestensis*, etc. Limestone, with *Pterocera pelagi.*	Marls, with Orbitolines and Echinus of Rimet (Isère). Limestone, with *Chama Lonsdalei.* Marls, with Orbitolines (1st zone) and with *Heteraster oblongus*, etc.
Limestone, with *Chama Ammonia.* Yellow Limestone of Neufchatel.	Limestone, with *Chama ammonia.*
Neocomien Marls, or Marls of Hauterive.	Marls, with *Toxaster complanatus.* Limestone, with *Crioceras Duvalii.* Limestone, with chloritic grains (glauconieux), with *Belem. pistilliformis* and *dilatatus.*
Russet Brown Limestone, with *Ostrea rectangularis.*	Russet brown Limestone, with *Ostrea rectangularis.*
Valanginian Limestone.	Limestone of Fontanil (Isère).
(Break.)	Marls, with *Belemn. latus*, *Am. Neocomiensis*, etc. Argilo-bituminous Limestone, with hydraulic cement: Fauna of Berrias (No. 5 of M. Pictet). Limestone and Breccia of Aizy (No. 3 and 4, id.). Limestone, with *Terebratula janitor* (No. 2, id.).
Fresh-water beds. Suprajurassic (Purbeck ?) Portland Limestone.	(Break.)
Marls and Limestone, with *Ostrea virgula.* Marls and Limestone, with *Pterocera pélagi.* Marls and Limestone, with *Astarte.*	Corresponding to a complete change of fauna
Limestone, with *Diceras.* Coral Rag.	

Region of the Central Jura. (Type situated between Besançon and Neufchatel.)	*Subalpine Region.* (Type neighbourhood of Grenoble.)
GAULT.	GAULT.
Upper Oxfordien; Terrain à Chailles; Argovien.	Limestone of the Porte-de-France, large mass (No. 1 of M. Pictet) *Amm. flexuosus*, *A. tortisulcatus*, *A. plicatilis*, *tatricus*, *iphicerus*, *etc.*; *Belem. hastatus*.
Oxford Clay.	Argillaceous Limestone and Marls, with geodes, *Belem. hastatus*, *B. latisulcatus*, *Amm. plicatilis*, *canaliculatus*, *tortisulcatus*, *oculatus*, etc.

M. Lory writes to me, on the 29th of April, "In all the papers where I have had occasion to refer to the beds with *Tereb. diphya* (or *janitor*, Pictet), of the Porte-de-France, of the lithographic limestone and of the hydraulic cement beds which lie above, either at the Porte-de-France, at Aizy, and other places in the neighbourhood of Grenoble, or at Lemenc, and other spots in the vicinity of Chambéry, I had always, until within the last few years, considered these beds as *Jurassic*. In 1851 I made known the fauna of the breccia of Aizy, as a last remnant of the extension of the coral limestone which terminated at the border of the Alpine mass (Bull. Soc. Geol. France, 2nd ser., vol. ix., p. 54), also the difficulty of tracing a limit between the *limestone of the Porte-de-France* and the base of the true *Neocomien* of the Alps (*ibid.* p. 52). I concluded that the Alpine mass had emerged above the sea after the deposition of the upper Oxford clay, before (or during) the deposition of the Coral rag, and subsequently replaced by a subsidence under the sea at the commencement only of the Neocomien period (*ibid.* p. 236, 238) an opinion adopted and maintained by M. Hébert, and upon which we were always agreed. I have since shown that the Neocomien deposits must have commenced in the Alpine region before they spread in the Jurassic one: Since in the latter the first deposits were the *Valanginian limestone* represented at Grenoble, by the *limestone of Fontanil*, above which we find again the large deposit of the marls with small *Ammonites*, and with *Belemnites latus* of the Mediterranean region (Bull. Soc. Geol., vol. xv., p. 30), so that the Neocomien sea came from the South, after having formed this deposit, and extended itself over the Jura at the period of the deposition of the Valanginian limestone and later again in the Haute Savona where we find only the marls with *Spatangus* (Desc. Geol. of the Dauphiné, p. 159 and 189).

"In my opinion, and I believe in that of M. Hébert, this deposition of Lower Neocomien strata took place during the long epoch of intermission of the marine deposits in the Anglo-Parisian basin, represented by the fresh water deposits of the Wealden.

"In the last paper which I published on these beds, I still maintained the upper beds of the Porte-de-France to be of Jurassic age on account of the Ammonites which D'Orbigny had identified as *A. anceps*, *viator*, *Hommairei*, *Adelæ*, etc., occurring in beds, some immediately below, and others above the principal horizon of the *Ter. diphya* (Bull. 2nd ser., vol. xxiii., p. 516), and above all, on account of the small fauna of the breccia of Aizy and Lemenc, which is believed to be incontestably Jurassic. Since then I have attentively re-examined the localities in order to furnish M. Pictet and M. Hébert with the stratigraphical data of which they were in need (neither the one nor the other having visited those localities in the neighbourhood of Grenoble), and I have arrived at the following conclusions: First, that the principal and lower mass of the limestone of the Porte-de-France contains a fauna which is entirely *Oxfordian*; it is terminated by a bed with large *Aptychus* (*A. lævis* and *A. lamellosus*) which form the bottom of the quarry of the Porte-de-France.

"Secondly: In a bed of compact limestone situated above the last described, the *T. janitor* (or *diphya*) begins to appear along with the Ammonites under discussion, which M. Hébert considers referable to *Neocomien* types, and which do not in any case occur along with the Jurassic fauna underneath: moreover, no species bearing an evident Jurassic type has been met with in this zone. Above this, beds occur containing scarcely any other fossils save *T. janitor* with *T. gratianopolitana* (Pictet). These are followed (always in the ascending order) by others containing *Ammonites*, the lithographic limestones are more developed and richer in fossils at Aizy, and with them is intercalated, as a local accident, the breccia of Aizy, of Lemenc, and other localities possessing a coralline facies.

"Thirdly: Finally above all these comes the Argilo-bituminous limestone with hydraulic cement, the fauna of which has been so carefully studied by M. Pictet. We cannot doubt then that this is the *Lower Neocomien* corresponding to the beds of Berrias.

"The impending discussion can therefore only bear upon the beds No. 2. Now it appears to me from the palæontological studies in connection with the fauna of this layer, that it has strong affinities with the *Neocomien* and contains *no Ammonite of a decidedly Jurassic type.* As to the Echinoderms and the Brachiopoda found in the breccia of Aizy, upon which my former opinion was chiefly grounded, they are open to discussion. Even supposing some incontestably Jurassic species should be found therein, as for example *Acropeltis æquituberculata*, *Megerlea pectunculoides*, *Terebratulina substriata*, etc., it is necessary to remark that they occur in a puddingstone, and in such a conglomerate, it is not impossible that these fossils, detached perhaps from the Jurassic beds, should have intermingled with the Neocomien ones, derived from the limestone immediately underneath. To the mind of any one acquainted with the locality, this breccia is evidently a shore-deposit, and this mixture of fossils, under such circumstances of deposition, would not be impossible. Therefore I am now entirely of the opinion of M. Hébert, or rather, I believe that the palæontological discussions raised on this subject will require to be solved in accordance with his opinion, which appears the only one that would agree with my stratigraphical studies.

"It is clear from the comparative table I have sent you, that *on both sides,* in the Jura and in the Alps there exists a break

CLASSIFICATION OF THE MIDDLE AND LOWER PORTION OF THE CRETACEOUS SYSTEM, BY M. F. J. PICTET, 24th April, 1869.

	England.	Swiss and French Jura.	Basin of the Seine.	Basin of the Rhone.	Alps.—South-West of Switzerland, South-East of France, Tyrol, Italy, Carpathes.	Germany.
Cénomanien.	9. Chalk Marl (Craie marnense). Upper Green Sand	Rhothomagien.	Rhothomagien. Upper Green Sand.	Rhothomagien. Upper Green Sand.	Cénomanien.	Cénomanien.
Upper Gault.	8. Gault of Cambridge.	Upper Gault or Vraconien.	Upper Gault of Cosne (Nièvre), etc.	Upper Gault of St. Julien of Peyrollas.	Upper Gault of the Col de Cheville. Gault, with mixture of species from 7 & 8. Lower Gault.	Flammenmergel.
Gault.	7. Gault of Folkstone.	Middle and Lower Gault.	True Gault.	True Gault.		Gault.
Aptien.	6. Lower Green Sand.	Upper Aptien. Lower Aptien or Rhodanien. Orbitolites.	Bed with *Ostrea aquila*. Aptien.	Aptien. Urgonien mixed with *Orbitolites*.	Aptien.	Speeton Kalk, etc., of M. Strombeck.
Urgonien.	5. ?	White Urgonien. Lower Urgonien.	Marls with Oysters (Marnes à Ostréennes), and Limestone with *Spatangi*; (calcaires à Spatangues).		Limestone with *Caprotina ammonia*.	Upper Neocomien.
Neocomien Proper.	4. Lower stages of the Speeton Clay. ?	Yellow Stone of Neufchatel. Marls of Hauterive.		Alternation in the Dept. of Isère of the Marls of Hauterive and the Marls with *Ancyloceras*.	Marls with *Ancyloceras* and *Terebratula Diphyoides*. Marls of Hauterive (often wanting).	Lower Neocomien.
Intermediate bed	3. Line B.	Bed with Sponges & Bryozoa.	Line B.	Marls with *Belemn. latus*, *Natica leviathan*. Neocomien of Berrias.	Beds of the Altmann (Sentis). Beds of Merlingen.	
Lower Neocomien or Valangien.	2.	Limonite. Lower Valangien.				
Titonic (Tithonique) or ? Limestone of Stramberg.	1.			Limestone of Aizy, and of the Porte-de-France, with *Tereb. janitor*.	Limestone, with *Ter. diphya* of Tyrol, Klippenkalk. Limestone with *Ter. janitor* of Stramberg.	

in the sequence of deposits, but these two breaks have not begun or terminated at the same time. The Supra-jurassic deposit, in which I was the first to show the existence of fresh-water fossils (Comptes Rendus de l'Acad. des Sciences, Oct., 1849), might perhaps have continued, whilst the first beds with *T. janitor* were being deposited, but additional confirmation by renewed stratigraphical and palæontological researches will be required before we can fix our ideas on the succession or partial synchronism of these breaks or gaps, which are very evident, and call loudly for further research, especially in the immediate parts between the Jura and the Alps."

To his table of the Middle and Lower Cretaceous period (*ante*, p. 255), M. Pictet adds the following explanatory notes :—

"No. 1.—*Tithonic* stage or *limestone of Stramberg*. I commence my table (in the ascending order) by a stage of which the position is still doubtful, thus raising one of the most controverted questions of the day. On this subject there exists a misunderstanding between M. Hébert and myself, but this disagreement has been much exaggerated. The facts are as follows: M. Hébert was the first to observe the Cretaceous aspect of the fauna of the Porte-de-France; to him therefore, incontrovertibly, belongs the merit of having first drawn public attention to this fact. This observation of M. Hébert's struck me the more forcibly from my having at the same time had occasion to study the remarkable fauna of Berrias, and that I found therein the confirmation of M. Hébert's idea of the existence of Neocomien faunas more ancient than those already known. I believe I was the first to determine that the section of the Porte-de-France contains three different stages. The jurassic, at the base, the true Neocomien at the top, and the Stramberg limestone in the middle. In the first instance I was censured for seeking to establish comparisons with the deposits of the Carpathians; subsequently, the necessity of so doing has been acknowledged, so much so indeed, that the only question now at issue, is that of determining the age of the Stramberg limestone (no one disputes its identity with the limestone of Aizy).

"In the table published (Mélanges Paléontologiques, 4th decade) I traced a line A which separates the Stramberg limestone from the underlying Jurassic period, and another line B which separates it from the limestone of Berrias situated above. I then suggested that the boundary of the Jurassic period was either on the line A or on the line B, or between the two. M. Hébert accepts the line A as the separation. We were no longer agreed when it was necessary to come to a definite understanding. M. Hébert thinks the question has been sufficiently answered, and admits without reservation that the Stramberg limestone belongs to the Neocomien period. I cannot so speedily arrive at that conclusion; I recommend more study, and require further evidence ere I decide.

"I coincide in his opinion that the evidence derived from the Cephalopoda is in favour of the idea that the Stramberg limestone is Cretaceous. Since the valuable researches of M. Zittel there is an increased analogy, a striking one, between Stramberg and the fauna of Berrias, and M. Zeuscher's researches on the *Nerinæa*, and that of Sig. Gemellaro on the fauna of the horizon of *Tereb. janitor* at Palermo, seem to denote on the contrary Jurassic affinities. I do not consider myself justified in denying the correct foundation of the identifications arrived at by these eminent palæontologists, and I consequently wait for a renewed discussion with regard to those species.

"From what I have already said, I am prepared to accept the idea of the Stramberg limestone being a portion of the Cretaceous system, but I shall only accept it as such when supported by satisfactory evidence, and this I repeat we do not at present possess.

"The fauna of the Klippenkalk (Carpathians) and that of the 'Rosso-Ammonitico' of the Tyrol are almost contemporary with those of Stramberg, and characterised by the true *Terebratula diphya*.

"As to the Stramberg fauna, the list of the fossils will be found in the works already quoted. The most marked are the *Tereb. janitor*, *Ammonites ptychoricus*, *A. Leibigi*, etc., *Nautilus Geinitzi*, *N. Picteti*, etc.

"No. 2.—*Lower Neocomien* or *Valangien*. Below the true Neocomien some lower beds are found, which it is not easy to correlate entirely, because they exhibit different facies. In the Swiss and French Jura two beds are in general observed in the *Valangien*, connected by a considerable number of well known species. The upper or *limonite* is the richest (see the Memoir of M. Jaccard relating to the map of Switzerland, and where at p. 164 upwards of 250 species are mentioned) the principal fossils of the Valangien are *Ammonites Marcousiana*, *A. Gevrilianus*, *A. Desori*, etc., *Natica leviathan*, *Pygurus rostratus*, etc. In the south of the basin of the Rhone we find again this same bed characterised by *Natica leviathan*. Beneath it is the beautiful fauna of Berrias, which I described in the 'Mélanges Paléontologiques, No. 3;' it forms a curious transition between the true Neocomien and the limestone of Aizy (Stramberg limestone).

"No. 3.—Is an intermediate bed which some geologists connect with No. 2 and others with No. 4. In the Swiss Jura it contains Sponges and *Bryozoa* and is believed to be Velangien. In the canton of Berne, and in the valley of the Rhone, this bed seems to be replaced by marls with a well defined horizon, containing *Ammonites Grasianus*, *A. asperrimus*, *A. Neocomiensis*, etc.

"No. 4.—The true *Neocomien* appears in two forms. A, the littoral, or shore facies, is spread over a large portion of France, the Jura, etc., and is divided according to the localities into two or three beds. The upper one is the 'Yellow Stone of Neufchatel,' the middle one is the 'Marls of Hauterive.' It is possible sometimes to separate from these last a lower bed with *Ammonites Astierianus*. The characteristic fossils are very numerous:—*Belemn. dilatatus*, *B. pistilliformis*, *Ammonites radiatus*, *Am. Leopoldinus*, etc.

B, the Alpine facies forms a long layer or band extending from the south-east of Germany and Switzerland to the maritime Alps, and returning through the Veronais. It is this facies which contains the magnificent fauna characterised by the unrolled Cephalopoda of the South, which very nearly corresponds to the Barrêmien of M. Coquand. *Belem. dilatatus*, *Amm. tethys*, *A. Rouyanus*, etc. *Ancyloceras Emerici*, *A. Tabarelli*, etc. *Tereb. diphyoides*, etc.

"No. 5.—*Urgonien.* Well characterized in the Swiss Jura, and having a closer connection with the yellow stone of Neufchatel than any other Aptien stage. It is questioned by some French geologists, because in certain southern localities of the basin of the Rhone it is reduced to beds, but slightly characteristic, containing Orbitolites, which elsewhere are strictly Aptien. In the Jura it forms two stages; the lowest is the richest. The forementioned memoir of M. Jaccard (map of Switzerland) contains a list of upwards of 120 species (*Nerinea orbensis*, *N. Crozetensis*, *Pleurotomaria orbensis*, *Pygurus productus*, *Heteraster Couloni*, etc.). The upper stage, in the Jura, seems exactly parallel with the limestone of Orgon, and contains the same *Caprotinæ*, *Lima Orbignyana*, etc.

"No. 6.—*Aptien.* A stage entirely distinct from the *Urgonien* in Switzerland. It forms two beds, inseparable on account of the great number of species common to both. The lower or *Rhodanien* (*Amm. Martini*, *A. furcatus*, *A. Campichei*, *A. Deshayesi*, etc. *Bel. semicanaliculatus*, etc.) possesses a numerous fauna (see our publications). The upper bed is composed of *hard green sandstones*, and has a close resemblance to the Gault and is parallel to the bed containing *Ostrea aquila*. These two beds, upon the whole, exactly correspond to the *Lower Green Sand*, a fact proved and established by us long since.

"According to our views, there is consequently in the South of England no Cretaceous deposit more ancient than our *Aptien*. As to the Speeton Clay, it is impossible for us to have an exact idea of it, notwithstanding Mr. Judd's description. It is necessary that a paper, accompanied by good plates, should replace, by its clear evidence, those catalogues replete with references to unpublished or little known species. Pray use your influence to induce Mr. Judd to render science the important service of completing this work.[1]

"No. 7.—*Gault.* The true Gault of Folkstone of the Yonne and the Aube is represented with us sometimes by one and sometimes by two beds, designated by the names of *Lower* and *Middle Gault.* It is rich in fossils.

"No. 8.—*Upper Gault* presents various aspects. In the Swiss Jura it is a mixture of species found in the Gault (*Amm. inflatus*, *A. Velledæ*) with forms ordinarily more recent (*Pecten asper*, etc.), and with some new species. It is the *Vraconien* of M. Renevier. In the Alps of the Canton de Vaud (Col de Cheville) an association tolerably similar is found very distinct from the Lower Gault. In the Alps of Savoy, on the contrary, there is frequently a mixture of species belonging to the Lower and the Upper Gault. The *Vraconien* appears to us entirely contemporaneous with the Upper Gault of

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[1] Mr. Judd informs me that he has at present in preparation descriptions accompanied by illustrations of the species which occur in the beds of the Speeton Clay, so that M. Pictet's earnest request will shortly be complied with.

Cosne (Nièvre), of St. Julien de Peyrollas (Gard), and it can scarcely be dissimilar from the Cambridge Gault or Green Sand.

"No. 9.—*Cénomanien.* The Grés vert Superieur (Upper Green sand) is not found in our regions in the shape of sandstone, but it seems replaced by the *Vraconien.* The *Rhothomagien* stage is a marl with *Turrit. costatus*, *Amm. rhothomagensis*, *A. Mantelli*, etc., *Inoceramus striatus* (but without *Pecten asper*), which directly reposes upon the Vraconien."

It will be observed from the tables and views already given, that a marked difference of opinion prevails with reference to the propriety of combining the *Aptien* and *Urgonien* into a single stage, M. Pictet and several other observers are of opinion that the latter is in Switzerland everywhere entirely distinct from the *Aptien*, while M. Coquand, Leymerie, and some others contend that the two alternate in certain regions named by them. This subject will consequently require further study and confirmation. Again, certain geologists would limit our Lower Green Sand to the Urgo-Aptien stage, while others include part of it at least in the Neocomien.

Some considerable difference of opinion has likewise been expressed, not only at home, but also on the Continent, as to the real value or position of the well-known Cambridge Green Sand or Phosphate bed. Some consider it to constitute a portion of the Upper Green Sand, while others would refer it to the upper portion of the Gault, and abroad some geologists constitute it a distinct stage, for which the term *Vraconien* is proposed. I found this identical Cambridge bed with the same water-worn fossils occurring at Ese, a locality not far from the shore, between Nice and Monaco, of which I will give a description in the sequel. It is a point of great importance to determine the exact age of this Cambridge bed, and in making a palæontological comparison, there are several points in the case which will call for especial caution; and, as suggested by Mr. Judd, we must in the first place determine whether there are any derived fossils in the bed (so often met with in beds of phosphate nodules). Secondly, can the distinctive character of its fauna be accounted for without having recourse to difference of age? For this purpose it will be necessary to apply the crucial test proposed by Edward Forbes, namely, whether the same group of organisms (genus, sub-genus, etc.) is represented by different *species?* In the Geol. Mag. vol. 3, p. 302, 1866, will be found an interesting paper by Mr. H. Seeley, "On the Cambridge Green Sand," to which the reader is referred; and I understand that the same gentleman has in preparation a work on the Geology of Cambridge, in which this important subject will, I hope, be thoroughly discussed, and that he will give us a complete list (with figures) of the species peculiar to it.[1] Another valuable paper "On the Albien or Gault of Folkestone," by Mr. C. E. de Rance, will be found in the Geol. Mag, for 1868, and we may obtain considerable fresh light upon the Gault from the careful and indefatigable labours of the Rev. T. Wiltshire in that same locality and formation. Indeed, many points of considerable interest still remain to be determined with reference to our Cretaceous system; and it was with the hope of stimulating further research that I have been led to offer in the pages of this Magazine the opinions entertained by foreign geologists.

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[1] Mr. J. F. Walker favours me with the following remarks: "You have called the *Cambridge phosphate bed, Upper Gault*, although the people here call it *Upper Green Sand.* I have long doubted the determination. I think that it has been formed by the *denudation of the Gault.* 1st. Because the common fossils are Gault species. 2nd. The species characteristic of Warminster are nearly absent. 3rd. The fossils

Having now given the views of most of the French and Swiss geologists with reference to the subject at issue, it will be desirable to cast a rapid glance at the position of matters in the North of Germany, where the Cretaceous system attains an important development. I have, therefore, requested the eminent geologist, Herren A. Von Strombeck, to forward me his most recent views, which he has kindly done in the shape of the following table. He informs me likewise by letter that the succession of beds which he transmits is not dubious, and has remained the same for a long period in all his memoirs. It is only the grouping and the comparisons that have undergone changes, and that the identification of a large proportion of the fossils (especially of the *Brachiopoda*) which he has published, at various periods, will require revision, consequently he has not introduced into his table the names of characteristic fossils, but, as a compensation, he includes the localities.[1] He also adds that in the Lower Chalk they have in Germany two levels or horizons which are entirely similar in other regions, that is to say, the Calcareous Clay with *Amm. Nisus* (Marls of Gargas), and the zone with *Toxaster complanatus* (=Marls of Hauterive). M. Strombeck infers that the Lower Green Sand of England is not the equivalent of the true Neocomien, but of the German zone with *Ostrea aquila,* which are rather more recent. It

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are often waterworn; you seldom find associated bones of reptiles, sometimes the reptile bones are broken and oysters are deposited on the fractured surfaces. 4th. The fossils are nearly always covered with the phosphate deposit, oysters are attached to the nodules; the nodules are rolled, appear to have been brittle, as I have found *pieces broken,* and the characteristic *Plicatula* attached to the *broken surface,* which would tend to prove that they had not been formed where they are found. 5th. The bed is *thin,* full of nodules, bones and shells; the green grains pass up into the Chalk, above the nodule bed, the clay below contains very few fossils (I have obtained fish vertebræ and *Plicatula pectinoides*). Now if the sea coast had consisted of *Gault Clay,* which was destroyed by the sea, the nodules, bones, shells, might be washed out (as the denudation of the drift clay forms beds of gravel) and form the Cambridge bed. This would give the reason for the mass of nodules, etc., accumulated in so small a space; some of the bones need not have rolled for a long time, but might be carried by currents into deep water, then we might get associated bones. 6th. It is possible that *T. gracilis* and some others may be of the age of the deposit, and may be found at the base of the Chalk. Bones that have *not* been through the washing mills are often waterworn, the *mills* used to be blamed for the appearance of the fossils.

[1] Mr. Judd is happy to be able to bear his testimony to the relations of the beds which M. Von Strombeck has made with so much skill and labour. When in Germany he saw most of the beds which he refers to in his table, many of them under his own guidance; but as there is no good general section in Brunswick, and detached stone pits, brick yards, etc., form the only means of study, he believes that considerable changes may still have to be made in the grouping of the beds.

appears to him also that the Upper Chalk of England and of the north of Germany exhibit a close similarity even in their details. That probably the same sea that deposited their Pläner extended directly into England. Moreover, that in Germany the red Pläner (zone with *Inoceramus mytiloides*) forms in the great mass of Limestone a band which can be easily recognized, and he enquires whether we have not that Red Limestone in England?

CLASSIFICATION OF THE CRETACEOUS SYSTEM IN NORTH-WESTERN GERMANY, BY HERRN A. VON STROMBECK. April, 1869.

Sénonien d'Orb.	Upper.	Zone of *Belemnitella mucronata.*	White Chalk of Rügen. Chalk Marl: Luneburg (in part), Duttenstedt, near Brunswick. Sandy Marl: Ahlten, near Lehrte, Haldem.	
		Zone of *Belemnitella quadrata.*	Marl: Northern margin of the Harz (Ilsenburg, Salzburg, near Quedlinburg,) Luisberg, near Aarhen. Conglomerate of the Sudmerbergs near Goslar. Subherrynian, near Upper Quader: Blankenburg.	
	Lower.	Zone of *Inoceramus Cuvieri.*	Upper Pläner: Steinlahe, near Salzgitter, Northwards from Pavillon, near Heiningen, not far from Wolfenbütter.	
		Zone of *Scaphites Geinitzi.*	Upper Pläner: Southwards from the Pavillon, near Heiningen, Brackwede, near Bielefeld, Strehlen, near Dresden.	
? Turonien d'Orb.		Zone of *Inoceramus Brongnarti*, in the upper part, full of *Holaster planus.* (Facies: Beds with *Galerites conica.*)	White Middle Pläner: Widely distributed in the neighbourhood of Salzgitter and in the Teutoburger Walde. Galerite-beds: Fleischercamp, near Salzgitter, Aahaus, in Westphalia.	
		Zone of *Inoceramus mytiloides* (*labiatus*).	Red Middle Pläner: Leibenburg, near Salzgitter. Lower Grey Marl on the Ruhr in Westphalia.	
Cénomanien d'Orb.		Zone of *Ammonites Rhothomagensis.*	Lower Pläner: Langelsheim, near Goslar.	
		Zone of *Ammonites varians* (*Scaphites æqualis*)	Lower Pläner: Neighbourhood of Salzgitter.	
		Zone of *Terebratula tornacensis.*	Tourtia-Essen in Westphalia, Northern Margin of the Harz.	
Gault. (Albien d'Orb.)	Upper.	Zone of *Ammonites inflatus.*	"Flammenmergel:" widely distributed in the North of the Harz and in the Teutoburger Walde.	
		Zone of *Belemnites minimus.*	Clay: Eilum, near Schöppenstedt.	
	Lower.	Zone of *Ammonites tardefurcatus.*	Clay: Quitzern, near Querum.	Sub-Hercynian Lower Quader (in part) between Halberstadt and Blankenburg-Delligsen in the Hills.
		Zone of *Ammonites Milletianus.*	Clay: Vohrum, near Peine.	

Aptien d'Orb.		Zone of *Ammonites Nisus.*	Calcareous Clay (Gargas-Marl): Mastbruch, near Brunswick.			
		Zone of *Ammonites Martini.*	Olhey, not far from Goslar, Frankenmühle, near Aahaus, in Westphalia.			
?		Zone of *Belemnites Brunswicensis.*	(Speeton Clay) Moorhütte, near Brunswick, Heligoland.			
(Neocomien d'Orb.) Hils.	Upper.	Zone of *Crioceras Emerici.*	Bohnencamp near Querum, not far from Brunswick.			
		Zone of *Ostrea Couloni var. Aquila.*	Clay, extending between Asse and Elm.	Ironstone near Salzgitter.	Sandstone of the Teutoburger Walde.	Lower Greensand ?
			Beds of Elligser-brinke.			
	Middle	Zone of *Toxaster Complanatus.*	Tackwelle near Berklingen in the Asse. (Marnes d' Hauterive).		Wealden formation.	
	Lower.		Gross Vahlberg in the Asse (Valanginien ?)		?	

NOTE.—The "Hils" is a range of lofty hills lying to the south-west of Alfeld, in Hanover. The "Elm" and the "Asse" are two Ranges of Hills near Schöppenstedt, in Brunswick.

In order to render M. Von Strombeck's table more clear to the English student, Mr. Judd has kindly, at my request, drawn up the following few notes on the comparison of the English and German Cretaceous, but intimates, at the same time, that this important subject requires ample discussion rather than categorical statement.

"The Mesozoic strata of north-western Germany and those of the north of England present many very interesting points of analogy, which perhaps point to the conclusion that both were deposited in the same hydrographical basin.

"Unfortunately the Chalk of the north of England has not yet been studied in sufficient detail to enable us to determine how far the palæontological classification, proposed by M. Von Strombeck, may be applicable to it. One very interesting point of resemblance, however, between the North-German Chalk and that of the North of England is the occurrence in both of beds of a red colour. It is in the middle Cretaceous that we find the most striking *differences* in the two series. This division is represented in the North of England by the thin formation of the red limestone of Hunstanton; while in Germany we find various beds of Clay of considerable thickness, the most important of which (from a fancied resemblance of its variegated markings to flames) is called the 'Flammenmergel.' The two zones classed by M. Von Strombeck as *Lower* Gault are not known in the western part of the North-German area; in England *they are equally* wanting, and it is not improbable that they repre-

sent, in part at least, the interval (indicated by unconformity) between the Gault and Neocomien.

"The Lower Cretaceous or Neocomien beds are strikingly similar in the two areas. The Clays classed as 'Aptien,' taken together with that called the Speeton-Clay,[1] by Mr. Von Strombeck, agree precisely, both lithologically and palæontologically, with the highest beds at Speeton, while the beds called 'Upper Hils' as closely correspond with the middle portion of the Speeton series, abounding with *Exogyra sinuata* and *Pecten cinctus*.

"The remarkable resemblance, both in mineral character and fossil contents between the two lowest zones (Hils-conglomerat in part of Fr. Ad. Römer) and the Tealby series of Lincolnshire is also very striking. The yellow sandstones of the Teutoburger Wald, so well described by Prof. Fred. Römer, are also very similar to the Lincolnshire beds. Studying the palæontology of these several strata by the light of the Speeton section, I am inclined to believe that they belong rather to the Middle than to the Lower Neocomien."

(*To be continued*).

IV.—Notes on the Growth of Soil.

By G. H. Kinahan, M.R.I.A., etc., etc.

PREVIOUS to writing "Suggestions on Denudation,"[2] I had not seen Mr. Darwin's paper "On the Formation of Soil;"[3] since then, having read this essay, it appears to me that instead of Darwin proving "the disappearance of stones, etc., needs no growth of soil," he advocates in a great measure the statement put forward in "Suggestions on Denudation." For Darwin clearly proves that any foreign substance placed on grass land will be gradually covered up *by a growth of soil over it.* This soil, however, he seems to believe to be entirely due to the labour of earth-worms, who excavate in the ground under the foreign substance and deposit over it. From this it would appear that this eminent observer considers that the *total thickness* of the soil is not increased upwards by mould formed from vegetable decay, but that all is taken from below the foreign substance and placed above it,[4] thereby adding to the thickness of the upper stratum of the mould and diminishing the thickness of the portion below the foreign substance. This, within certain limits, may be correct; but can anyone assert that the decay of the yearly growth of vegetable matter is *nil*, and that it cannot possibly add its mite, no matter how small, to the thickness of the soil? If the above is the case, how can we account for the growth of peat bogs in Ireland and other countries? On the site of all peat bogs (or the bogs in the low flat country) there originally was vegetable soil, in which trees and lesser plants grew;—on this, by the decay of the vegetable matter, a spongy soil was formed that retarded the drainage, and was well fitted for the growth of such mosses as the *Sphagnum*, which began to luxuriate. The earthworms, it is probable, helped to form the vegetable mould in the first instance, but after the drainage was stopped they could not inhabit the place, therefore their part in the work ceased and only the decay of the successive growth of the plants could add to the surface. The growth of the bogs has been ably treated by Portlock in the Memoirs of the Ordnance Survey of Londonderry, and by Nimmo and Griffith in their "Bog Report,"—therefore it is unnecessary to enter further into the subject. Even from Darwin's examples it would appear evident that the growth of soil cannot alone be due to worms; for spread a layer of lime on a field and the worm, to quote that Author, "is unable to swallow coarse particles, and the finer earth lying beneath would be removed by a slow process to the surface." Thus eventually all the matter that could be reduced small enough to be swallowed by the worms would be brought above the lime, and only the pebbles and fragments of stones left below; so that above there ought to be only this fine earth, while below there ought to be only gravel and sand. This is the result that ought to occur if to the worms alone is due the vegetable soil; but if they worked in conjunction with the decay of the vegetables, and principally in the soil due to that decay, there would be a continual shifting of a soil in which few pebbles ever existed. This, however, would necessitate the surface of the subsoil remaining permanent,—a subject, the consideration of which must be deferred till further on in these notes.

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[1] The Belemnite, which I have stated in my lists as *B. semicanaliculatus* (non de Blain.) is without doubt the *B. Brunswicensis* v. Stromb. During a recent visit to Germany for the purpose of studying the Neocomien strata of that country, I received much very kind assistance from several geologists, and especially from M. Von Strombeck.—J. W. J.

[2] Geol. Mag. No. 67, Vol. VI. p. 109.

[3] Trans. of the Geol. Soc. 2nd series. Vol. v. p. 505, *et seq.*

[4] Although not actually stated, it seems to be inferred that the soil increases in thickness downwards, the worms burrowing into the subsoil and thereby changing its nature. This subject will hereafter be referred to.

Nearly all the examples put forward by Darwin were observed in rich highly cultivated ground where earthworms abound, therefore the growth of the worm-formed soil must have been more rapid than would ordinarily be the case, and the part added, through the decay of the vegetable matter, may not have been very apparent; Nevertheless, in one instance, he seems to prove that the vegetable decay, not the earthworms, buried the foreign substances; namely, that of the boggy field which was covered over with a coat of gravel, and in two years and a half afterwards, there was a peaty layer three-fourths of an inch thick grown over it. Very similar instances occur, and may be examined in many places in Ireland among the reclaimed cutaway bogs, or as they are locally called *Moors*. These moors are generally tilled for a few years previous to being laid down in grass, after which a coat of marl or gravel is spread on them. If they are to be kept in good heart more gravel or marl from time to time must be applied to them, and the drainage attended to; but if they are neglected, as is too often the case, they will attempt to return to their former state, and in a short time a layer of peaty soil will grow on the marl or gravel. It is not uncommon in these moors, if a section is opened through them, to see one, two, or even three of these layers of foreign matter, pointing out the number of times the moor was "brought in," and afterwards allowed to run wild.

Any one acquainted with bogs well knows that earthworms cannot live in them. They will be found in reclaimed moors in the made soil, both while they are in tillage and grass land, but once the original boggy nature again predominates they disappear, so that they cannot assist in making the upper stratum of soil above the gravel; moreover, if this upper stratum is examined, it will be found to be of the same plaity or rudely laminated structure, similar to that of all bogs that grow from the successive layers of decayed vegetable matter.

Those conversant with highly cultivated rich grass land, can scarcely have failed to remark the enormous worm-work that yearly goes on, but this is not the case in all lands, for in many (not all) over chalk and limestone there is little or no worm-work, and also in poor sandy soils or in 'slob-land' newly reclaimed from the sea. On many chalk and limestone lands as mentioned in "Suggestions on denudation," "stones grow," but in poor sandy soils or in slob-land, although it may be the work of time, yet eventually there will be a surface soil formed by the decay of the vegetable matter, and all the stone will be covered up by the growth of the soil. In such soils at the beginning of the growth of the vegetable clothing, earth worms will be rare; in fact they cannot live without organic food, therefore until the vegetable life began they could not exist. As the vegetable soil increases, so will the earthworms, showing that the two agents work together, also that the growth of the vegetable soil is due, not only to its decay, but also to the worm-work; when the soil becomes rich, the latter agents do the major part of their work, but while it was poor, they could do little or none, owing to the paucity of their number, so that to vegetable decay was due the growth of the first mould.

Lands with a permanent turf or sod, that has remained untilled for ages, may be used either as pasture or the grass may be cut to dry into hay. If the surface soil were due only to the earthworms, apparently, in a field all of which has the same fertility, subsoil, etc., if a part is used as permanent pasture, while from the rest hay is always cut, the condition of the whole ought to be similar, and there would be a gradual increase of the mould of the same. This, however, is well known to the farmer not to be the case, for the surface will increase on the pasture-land, but not on the permanent meadow, except the latter is cut early enough to allow of a second growth or "after grass," which is left to rot on the ground. To counteract the injurious effect of removing all the vegetation, which naturally should decay on it, from the meadow-land, the land has to be top-dressed with foreign substances; moreover, all farmers state that mowing machines are harder on meadow-land than hand mowing, because the latter do not or cannot cut as close as the former, and for similar reasons horses are harder on grass land than either sheep or cows. It may be said that on pasture land the vegetable products are not allowed to decay. In one sense they are not, but if they are eaten off by the cattle they are returned again to the surface, their fertility being increased from their having been used as animal food.

In a comparison between meadow and pasture land, the "hand joined in hand" work of vegetation and of the earthworm appears conspicuous. Examine a meadow field after the hay is cut, and the worm-works will be found to be few and far between, but if the after-grass is allowed to rot on the land, and during that process the field is examined, worms will be found working everywhere among the decaying vegetable matter; and in the pasture-land there will be a hundred worms for every one in the meadow-land, the largest portion being found under and associated with the decayed vegetable matter in the droppings from the cattle.

Although, as previously stated, Darwin seems to infer that the thickness of the mould does not increase upward, that is, its height is not added to by an increase from the decay of the vegetable matter, although the full thickness may be increased by the earthworms working up part of the subsoil; yet in no instance is a fact put forward that would favour such a supposition. But on the other hand, facts may be stated which apparently would prove that it does increase upwards. To give a homely instance. Previous to the introduction of wire railings, the usual fencing in parks and pleasure grounds were iron hurdles with double knee-shaped legs. When the hurdles were placed in position, they were forced down till the knees were on a level with the surface of the ground, but in a few years the knees were not only covered, but a greater or less thickness of soil had grown over them. A stone, a piece of crockery, or some such substance, although not probable, might possibly sink bodily with the whole surface of the ground as the earth was excavated from below by the earthworms, and carried up by the same agents to be placed on the surface; but this could scarcely be the case with a railing half a mile or more long, and yet over every knee I have observed an equal growth of mould. But if there is an increase upwards in the thickness of the soil due to vegetable decay, it would be natural to expect that each knee of the different hurdles should be gradually and at the same time covered.

Darwin brings forward a startling fact in favour of the burrowing powers of the earthworm, in his quotation from Mr. W. Lindsay Carnegie's letter, however that may possibly be an exceptional case; for in the alluvial earth, forming some of the flats adjoining rivers in Ireland, such as that along the Little Brusna, the river which divides Tipperary from the King's County, I have, during the arterial drainage works in operation nearly twenty years ago, observed the burrows of the earthworms at great depths, but usually they seem incapable of penetrating into the ordinary sub-soils that occur in Ireland. The gravelly sub-soils formed by the Esker or post-drift gravels ought to be soft enough for them to work into, yet I never remember remarking a worm-burrow in them. The usual sub-soil, the limy Boulder-clay drift they never burrow in, and a sub-soil frequent in some places, namely, a stratum of bog-iron-ore, they could not possibly enter; yet over all these different kinds of sub-soil the surface mould increases if the land is laid down in permanent grass. The beginning of the soil forming the land over a subsoil of bog-iron-ore, cannot possibly be due to anything but chemical action and vegetable decay, as no worm-work could have been done; and if in such an instance a surface soil can be formed without their aid, why is it that similar work does not go on in other places? Moreover, in such places the work is carried on under most adverse circumstances, for every one ought to know that a bare surface of limonite is not a very favourable place for vegetation, and usually it appears due to the decay of the water lodged on the surface, with perhaps a slight disintegration of the underlying mineral, from which are generated lichens and mosses, and eventually a peaty soil. It, however, is added to very gradually, for in dry weather, there being no depth of earth, the vegetation is withered away.

Land that for years has been tilled to one depth will have a surface to its sub-soil like a road, and this is so well known, that to counteract it sub-soiling has been introduced. If such land is laid down in grass and subsequently again broken up, the surface of the sub-soil, caused by the former tilling, will be found intact; but the depth of the mould will have increased in proportion to the number of years it has remained under grass. This increase cannot take place below, as the old sub-soil surface still remains, therefore the mould must have increased in thickness upwards, and necessarily by the decay of the vegetable substances. It may be said that this is an exceptional case; for naturally this road-like surface would not be formed over the subsoil. However, if the thickness of the mould increases downwards, is it not remarkable that over each different kind of sub-soil the thickness of the vegetable mould should be so uniform? Naturally the mould is only a few inches thick over gravel, a little thicker over clay, a good depth over a sub-soil formed of a combination of clay and sand, more especially if it is limey, while over an alluvial sub-soil it may be any depth; unless, indeed, that *chemico-fluvial* denudation in each several case has removed an exact equivalent from the surface for the increase below; but this is highly improbable.

Before leaving the subject it should be mentioned that there are remarkable facts in connection with the decay of drift and its change into silt, that may bear on the growth of soil. One of these is well exemplified in a river that is partly subterraneous and partly subaerial; flowing partly between banks of Boulder-clay-drift and disappearing, not in an open vent, but through a filter formed of the insoluable parts of the drift. Such a stream, during floods, wears and cuts away the drift banks, and when it dries up there is a thick coat of fine silt over the natural filter; while in the bed of the stream there will not be blocks and fragments of rock in due proportion to those that were in the drift denuded away during the previous winter, and consequently much less than the quantity that ought to have been left as a residue from all the mass of the drift carried away.[1] From this it would appear that some drift can, in a way not yet explained, change into fine silt, the blocks and fragments of stone disappearing, and in some such way it might be possible that the stony residue from the worm-formed mould might also disappear, and thereby the thickness of soil be increased from below; however, against this idea still remains the facts stated as to the thicknesses of the mould over the different kinds of sub-soils.

From the above notice it appears that the writer cannot agree with Mr. Darwin in believing that in the formation of the surface mould "the whole operation is due to the digestive powers of the common earthworm." But although Darwin disagrees with him in this particular, yet *all the observations of this eminent Naturalist go to prove that in grass land chemico-fluvial denudation is stopped*, unless, indeed, part of the worm-formed earth is carried off by that denudent. The latter, however, could scarcely be possible (save in some exceptional case), for if this agent so acted, it must reduce the quantity of the worm-formed earth, which otherwise would be much more considerable than at present.

V.—ON THE FLOW OF RIVERS AND THE MEASURE OF RIVER SEDIMENTS.

By R. RUSSELL, Esq., of the Geological Survey of England and Wales.

THE importance of experiments and investigations such as those recorded by the Rev. J. D. La Touche, in the GEOLOGICAL MAGAZINE for April, can hardly be over-estimated from a geological point of view, and, if carried on in numerous districts and for a sufficient length of time, would furnish data with which, and a basis from which, future calculations as to the rate of denudation at present going on over the land surface of the globe might be estimated. For it cannot be denied that at present there is a laxness in the method of computation as regards the rate and amount of degradation both for past and present epochs which ill accords with the ultimate end and aim of all scientific pursuits, viz., truth. Each one taking a rate which seems most to confirm his own particular tenets, as, for instance, the different rates at which the river Niagara has cut its way back from Queenstown Heights to the present situation of the Falls. It has been taken as three feet, one foot, six inches, and one inch per annum, by different computators. Now I do not say that investigations on the river action of the period in which we live will clear up all such anomalies, because these observations will be of more service in estimating the future rate of the wearing down of the materials composing the land than that of the past, as there would always be the difficulty of ascertaining with precision the volume and velocity of the rivers, and the different elevations at which the land was situated at the particular era under consideration; still it would be a fulcrum on which we might rest the lever of analogy, and raise many questions at present resting in obscurity and doubt into light and certainty. Mr. La Touche will confer a lasting benefit on geological science by continuing these investigations, and still more so by carrying them on with more completeness and accuracy. It would be well to determine the rainfall in the catchment basin from whence the river Onny derives its waters, then knowing the volume of water which is carried away by the river, the ratio of the available rainfall for the purpose of carrying away sediment to the total rainfall may be determined. A system of observations, such as he refers to, carried on throughout the whole of Great Britain would be of great value in many respects; and by means of which the amount of material annually carried to the sea from the different strata which may constitute the basin where the water is collected (such as steep surfaces of granite, gneiss, and slate; moorland and hilly grounds covered with pasture; gently undulating and flat cultivated tracts of country), might be obtained.

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[1] The river that flows from Lough Cooter County Galway, at the place now called the "Devil's punch bowl," a few miles southward of Gort, has gradually eaten into an accumulation of Boulder-clay drift, until the drift cliff over the vent, a natural filter, is about 100 feet high. This drift is similar to the general Boulder-clay drift of the central plain of Ireland, being boulders and fragments of Carboniferous limestone with some of sandstone, contained in a clayey, slightly sandy matrix. Yearly this stream during floods, carries away a mass of the drift, yet when the water is low, few or none of the boulders and fragments that apparently ought to have been left as a residue of the drift can be seen, the river bed containing scarcely anything else but angular cherty gravel. Some parts of the blocks and fragments may have disappeared by abrasion, and the limestone may possibly dissolve and go away in solution, but how have they disappeared so rapidly, and what has become of the pieces of grits and sandstones? The latter are not very numerous, yet there are many of them, and how have they disappeared, as they could not have gone through the filter, and they could scarcely have dissolved and gone off in solution?

These investigations having been continued for a lengthened period, the estimation of flow in different years, and the amount of sediment brought down might be computed with great exactness in the future, because the discharge and sediment for a number of years having been obtained by means of a series of observations, any one of these years, or a particular portion of one of them, may be used to calculate the greatest, mean, and least discharge for a consecutive number of years, or parts of a year, by multiplying the discharge as formerly obtained by the proportion which the rainfall in those years, or parts of a year, as observed at the standard station, bears to the rainfall at that station during the time that the river was guaged.[1]

As for the different modes by which rivers may be gauged, there are a variety, and the most accurate is by means of the weir gauge; but it is applicable to small streams only. When a float is used, the

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[1] If we suppose that r is the rainfall, d the discharge, and s the sediment, during any part of the period when the experiments were conducted; r_1 the rainfall, d_1 the discharge, and s_1 the sediment, at any future equal length of time, then—

$$r : r_1 :: d : d_1 \text{ and } r : r_1 :: s : s_1$$

$$\therefore\ r : r_1 :: s : s_1$$

$$\therefore\ s_1 = \frac{r_1}{r} s$$

float ought to be of such weight as barely to reach the surface of the water, so as not to be affected by the wind, by this means the velocity of the swiftest part, or the centre of the stream, can be obtained, and the mean velocity may be calculated from the greatest velocity by an empirical formula, which I give on the authority of Prony.

Let $V =$ mean velocity.

$V_1 =$ greatest velocity. Then $\frac{V}{V_1} = \frac{V_1 + 7.71 \text{ feet per second.}}{V_1 + 10{\cdot}28 \text{ feet per second.}}$

By the use, however, of a current metre, the velocity can be measured at any point, and at any depth, in the cross section of the river under consideration. Professor Rankine recommends, as the most convenient instrument for this purpose, "a small light revolving fan, on whose axis there is a screw, which drives a train of wheel-work, carrying an index that records the number of revolutions in a given time. The whole apparatus is fixed at the end of a pole so that it can be immersed to different depths in different parts of the stream."[1] Whence the mean velocity can be obtained.

With regard to the rate at which the materials forming the bed of the river are carried along and worn down, it depends on the velocity and flow, and what the nature of the bed of the stream really is, since the bed of a river may be stable as when it is composed of rock, unless when exposed to a very strong current, or it may be stable in the ordinary state of the river, and unstable during floods, as when it is composed of stones and gravel; or it may be permanently unstable, as in the case of a muddy bottom. This last arises from the fact of the stream carrying matter in suspension, and which is just heavy enough to subside; but the least increase in velocity once more carries it forward. Du Buat states that the bed of a stream in a permanent condition of instability exhibits a number of transverse ridges, each with a gentle slope at the up-stream side, and a steep slope at the down-stream side. The particles of the bed are rolled by the current up the gentle slope till they come to the crest of the ridge and eventually drop down the steep slope to the bottom of the furrow, where they become covered up, and remain till the gradual removal of the whole ridge leaves them again exposed.[2] An exact counterpart of the sand blown into ridges by the wind, as described by Sir Charles Lyell, when speaking of the ripple mark.[3]

Observation alone could determine with certainty the size of pebbles and shingle which a known velocity of current would propel, and it would be easy to make a series of experiments by exposing sand, clay, pebbles of various sizes, shingle, rock, etc., to known velocities, and noting that velocity which just carries them along. The requisite velocity of current can always be obtained from a given head of water, taking into consideration the friction of the orifice through which the stream issues from the reservoir, and flows into the channel where the material to be tested is situated. A table, given by Du Buat, shows the greatest velocity of the current close to the bottom of the river, so as not to interfere with the stability of the substances of which it *is composed*.[4]

Soft clay	0·25 foot per second.
Fine sand	0·50 „ „
Coarse sand and gravel as large as peas	0·70 „ „
Gravel as large as French beans	1·00 „ „
Gravel one inch in diameter	2·25 feet „
Pebbles, one inch and a half in diameter	3·33 „ „
Heavy shingle	4·00 „ „
Soft rock, brick, earthenware	4·50 „ „
Rock, various kinds	6·00 „ „

From this table we may compute the rate at which the materials are drifted along the bottom, the velocity of the current being known, and also the average size of the sand and gravel of which the bed and banks of the river are composed. We can always estimate the pressure in lbs. on the square foot, which a given velocity will produce, because if we express that velocity in feet of water, a simple calculation gives us the force of the current in lbs. on the square foot or square inch, as the case may be. Let v equal the velocity, h the head of pressure due to that velocity, and p the pressure in lbs. on the square foot, then $h = \frac{v^2}{2g}$, g, being the force of gravity in absolute units, per unit mass, in the latitude of the place; and $p = h\ 62{\cdot}4$ lbs. on the square foot, or p being the pressure on the square inch, $p = \frac{h\ 62{\cdot}4}{{\cdot}144}$.

Professor Rankine states "that the least velocity of the particles of water in contact with the bed of the river is about as much less than the mean velocity, as the greatest velocity is greater than the mean, and that they might be taken as bearing to each other the ratios 3, 4, and 5. In very slow currents they are nearly as 2, 3, and 4."[5]

The results obtained by Messrs. Humphrey and Abbot, after a long-continued series of very careful measurements on the flow of the Mississippi river, and the amount of sediment annually carried down by it to the ocean, give about $\frac{1}{1321}$ as the solid contents, but they also concluded that sand and gravel was pushed along the bed to the very mouth of the river to the amount of $\frac{1}{10}$ of the mud held in suspension. Some observations made on the earthy matter brought down by the Ganges at Ghazepoor by the Rev. Mr. Everest, show how much the sediment varies at different periods. He gave the average amount of sediment suspended in the water during the floods as $\frac{1}{428}$ part by weight, or $\frac{1}{856}$ part in bulk. He also found that the proportion of solid matter held in suspension during the dry season was but small compared with that during the rainy season, being only in the ratio of 1 to 159·4,[6] and the ratio of the quantity during the eight months of the winter and dry seasons, to that of the four months of rain was 1 to 21·263.

The ingredients held in chemical solution ought also to be taken into consideration, as in some streams the amount is anything but insignificant, and it also expresses a certain rate of decomposition and wearing away, as proved by the suites of caverns which are found to exist in all limestone formations.

[1] and [5] Civil Engineering, Professor Rankine. [2] and [4] Hydraulics, M. Du Buat.
[3] Elements of Geology, Sir Charles Lyell. [6] Principles, Sir C. Lyell.

VI.—NOTE ON POST-GLACIAL LAKE-BASINS IN WESTMORELAND.

By S. R. PATTISON, F.G.S.

THE little village of Crossby-Garrett, near Brough,. appears to occupy the site of a Post-glacial lake. Lower Carboniferous strata compose the fell to the south, the lowest beds being yellow earthy limestones. Below this, in all the gorges, are deep red shales of the uppermost Old Red. and on the summits of some of the hills to the south are outliers of the New Red; the Drift lies in patches and contains mud, sandstone, and numerous blocks of Shap granite. The gullies coming down from Crossby fell converge at the gate of the village, and show excavation in Boulder drift. The bed of the torrent is dry during the greater part of the year, it receives only the surface water, which, as it falls swiftly down the valley through the Drift, makes rough work of its sides every freshet. Underneath the church hill, at the lower end of the village, the remains are visible of the dam which once enlaked the little valley. It has been clean cut through by the bursting of the Lake, and the banks of the excavation, and bottom of the old lake are now occupied by cottages and gardens. Another small lake existed near the village, in fields still called the tarn-fields, but whilst the former must have been drained, probably in pre-historic times (judging from the subsequent work of the torrent), the latter has disappeared by artificial drainage into the Smardale beck within a century.

The lower limestones where they are exposed in the ravines, are more than usually holed into pots and pans; a notable instance occurs at Great Asby, where the principal pothole in the present course of the stream is 14 feet deep, worked smooth, in the shape of an old oil jar. Close to this are some caves in the limestone, one extending for two miles, which deserves thorough exploration. I saw no trace of cave earth or remains near the entrance. The caves form the outlet for water during much of the year, but there may be remains preserved under some of the upright fissures, in the cheeks of the cavern.

I endeavoured to ascertain the rate of progress in the boring of the pots and pans, but beyond the fact that the breaking in and breaking down of some, had changed the course of the stream within living memory, and that those now receiving the water had sensibly increased within recollection, I could get no fact worth recording. The aspect of these valleys so pitted with bench marks made by the torrents, during many thousand years at least, is worthy of note.

NOTICES OF MEMOIRS.

I.—LEONHARD UND GEINITZ'S NEUES JAHRBUCH FÜR MINERALOGIE, GEOLOGIE, UND PALÆONTOLOGIE. Jahrgang, 1868; Hefte 6 und 7. Jahrgang, 1869; Erstes Heft.

BARRANDE, on the Silurian Fossils of Hof, in Bavaria; Zirkel, on the Distribution of Microscopic Nepheline; Zaddach and

Runge, on the Tertiary Rocks (with Brown-coal, Amber, etc.) of the Samland in the Baltic; Zeuschner, on the Devonian Dolomite between Sandomierz and Chenciny (Poland); Blunn, on some Pseudomorphs; Scharf, on Rock-crystal, from Carrara; Credner, on the Native Copper of Lake Superior; Roemer's account of the Meeting of German Geologists at Hildesheim, and of some other meetings of Naturalists in Germany and Switzerland; Von Haver's notice of the summer work of the Austrian Geological Survey, in 1868; Petersen, on the Basalt and Hydrotrachylyt of Rossdorf, near Darmstadt; Fuchs, on Vesuvian Lavas; and numerous letters by good observers and deep thinkers, on original and casual subjects, constitute the chief matter of these three numbers of the Jahrbuch, besides the usual valuable concise notices of current Geological and Mineralogical Literature. There are several illustrations.

Our German brethren evidently lose nothing of their love of mineralogy and of patient research in the character and history of rock-masses;—subjects that are not widely studied in the British Isles. We see, however, that fossils and geology are not at all neglected, and are well represented in the papers before us. Indeed, we have much to thank the editors and writers of the Jahrbuch for: much new information, carefully worked out, being given in the current parts of this valuable magazine. We hope that its circulation among scientific men in Britain is on the increase.

II. DESCRIPTION OF *PARKERIA* AND *LOFTUSIA*, TWO GIGANTIC TYPES OF ARENACEOUS FORAMINIFERA. By Dr. CARPENTER, V.P.R.S., and H. B. BRADY, F.L.S.

[*Communicated to the Royal Society, April 22nd,* 1869.]

THE authors of this Memoir commence by referring to the separation of the series of *Arenaceous* Foraminifera from the *Imperforate* or *Porcellanous*, and from the *Tubular* or *Vitreous*, first distinctly propounded in Dr. Carpenter's "Introduction to the Study of the Foraminifera" (1862), on the basis of the special researches of Messrs. Parker and T. Rupert Jones, who had pointed out that whilst there are several genera in some forms of which a cementation of sand-grains into the substance of the calcareous shell is a common occurrence, there are certain genera in which a "test" formed entirely of an aggregation of sand-grains takes the place of a calcareous shell: and that these genera constitute a distinct family, to which important additions might probably be made by further research.

The propriety of this separation of the *Arenacea* from the calcareous-shelled Foraminifera has been fully recognized by Prof. Reuss, the highest Continental authority upon the group; who had come to accept the principle laid down in Dr. Carpenter's successive Memoirs (Phil. Trans. 1856-1860), that the *texture of the shell* is a character of fundamental importance in the classification of this group, the *plan of growth* (taken by M. d'Orbigny as his primary character) being of very subordinate value; and who had, on this basis, independently worked out a systematic arrangement of the entire group, which presents a most remarkable correspondence with that propounded by Dr. Carpenter and his coadjutors. And their anticipation of important additions to the Arenaceous series has been fully borne out, on the one hand by the discovery of several most remarkable new forms at present existing at great depths in the ocean, which has been made by the dredgings of M. Sars, jun., and those of the "Lightning" Expedition; and on the other by the determination of the real characters of two fossils, one of the Cretaceous, and the other probably of the earlier Tertiary period, which prove to be gigantic examples of the same type.

The first of these, discovered by Prof. Morris more than twenty years ago in the Upper Greensand near Cambridge, was long supposed to be a Sponge; but his more recent discovery of two specimens which had been but little changed by fossilization, led him to suspect their Foraminiferal character; and this suspicion has been fully confirmed by the careful examination made of their structure by Dr. Carpenter, to whom he committed the inquiry, and by whom, with his concurrence, the name *Parkeria* was assigned to the genus. The second, which was obtained by the late Mr. W. K. Loftus from "a hard rock of blue marly limestone" between the N.E. corner of the Persian Gulf and Ispahan, bears so strong a resemblance in its general form and mode of increase to the genus *Alveolina*, that its Foraminiferal character was from the first recognized by the discoverer; but as all the specimens brought by Mr. Loftus had undergone considerable alteration by fossilization, their minute structure, though carefully studied by means of transparent sections, could not in the first instance be satisfactorily made out. When, however, Dr. Carpenter's investigation of *Parkeria*, with the full advantage of specimens but little changed by fossilization, revealed the very remarkable plan of its structure, the investigation of this type was resumed by Mr. Brady (who assigned to it the name *Loftusia*), with the new light thence derived: for as transparent sections of infiltrated *Parkeriæ* furnish a middle term of comparison between specimens of the same type which retain their original character, and transparent sections of infiltrated *Loftusiæ*, the last-mentioned can now be interpreted by reference to the preceding; so that the obscurities which previously hung over their minute structure have been almost entirely dissipated.—The description of the structure of *Parkeria* in this memoir is by Dr. Carpenter, and that of the structure of *Loftusia* by Mr. H. B. Brady; but each has gone over the work of the other, and can testify to its correctness.

The specimens of *Parkeria*, which have been collected by Prof. Morris, are spheres varying in diameter from about 3–4ths of an inch to about 1¼ inch. But Mr. Henry Woodward has placed in the author's hands a specimen from the Upper Greensand of Ventnor, in the Isle of Wight, which is not less than 2¼ inches in diameter. It is interesting to remark that the "nucleus" of a smaller specimen in the cabinet of J. Starkie Gardner, Esq., F.G.S., from the same locality, consists of a considerable number of chambers arranged in a *spire*, the structure of its concentric spherical layers being exactly the same as in the specimens described. A detailed description, with plates, will shortly be published by Messrs. Carpenter and Brady.

REVIEWS.

I.—PROFESSOR HUXLEY'S ANNIVERSARY ADDRESS TO THE GEOLOGICAL SOCIETY.[1]

ANY praise of this admirable address is superfluous. Its terse nervous English, its fertility and readiness of illustration, its wit, if such a thing is admissable into a scientific essay, and its straightforward and logical pleading are beyond praise, and geologists may well congratulate themselves on having met with such an advocate. We propose therefore to discuss the one point on which we cannot quite agree with the author. The main aim and object of the paper is to defend British geologists against a charge brought against them by Sir W. Thomson of being in "direct opposition to the principles of Natural Philosophy." The point on which issue is joined is that of time, Sir William asserting, from a study of the constitution of the sun, and other cosmical questions, "that the existing state of things on the earth must be limited within some such period of time as 100 millions of years;" while, as is well known, most geologists have hitherto been accustomed to hold in a vague way that they have proof that the lifetime of our planet has been far longer.

Before coming, however, to the defence proper, the author gives a sketch of the present state of geological thought, dividing geologists into three schools, the Catastrophists, the Uniformitarians, and the Evolutionists. The first two, whose names we are already familiar with, though they differ radically on almost every other point of importance, agree in setting certain limits to legitimate geological speculation. The Evolutionists, who, though they were to be found after a fashion among the earliest cultivators of the science, now receive perhaps for the first time a name, know of no bounds to their speculations, and fearlessly let their thoughts wander back to the birthtime and earliest infancy of our planet, and do not shrink from conjecturing what will be its future history. While paying all due honour to Hutton, the founder, and Sir C. Lyell, the modern expounder of the doctrines of the Uniformitarian school, Prof. Huxley blames them both because they have attempted to limit geological speculation to those periods of which records remain in the rocks of the earth, and have declared that their science has nothing to do with those dark and far distant ages of which no records have survived, when this planet may have existed as a nebulous mass or a fiery ball of molten matter. We think they are right. We can conceive a science which has for its object the collection and deciphering of the evidence contained in those stony documents in which a portion of the earth's history is darkly written; and we can conceive another science, which shall call to its aid a strong imagination, checked by such analogy as is applicable to the case, and shall frame theories as to what may not unreasonably be supposed to have been the state of the earth in those earlier ages of which no records remain; and the two sciences have much in common, both make large calls upon the imagination, but the checks furnished by evidence in the two cases differ so totally in degree, that for clearness of thought it is far better to keep them apart, and call them by different names, the one Geology, and the other Cosmogony.

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[1] Quart. Journ. Geol. Soc. Lond. 1869. Vol. xxv. Part 2, pp. xxviii.-liii.

And many an enthusiastic geologist fights shy of the latter on account of the absence of any definite evidence on which to base his reasonings; this must have escaped Prof. Huxley when he would have us believe that it is as easy to unravel the complexities of the development of the earth as to trace out the development of the fowl within the egg. We can examine as many eggs as we like, during all stages of incubation, but when shall we be able to put our theory of the earth's development to the test of observation? And this brings us to the real gist of the question, that our knowledge is not yet sufficiently advanced to enable us to found a well grounded Cosmogony. No better proof of this can be brought forward than a controversy on the chemistry of the primæval earth, which took place about a year and a half ago between two of the leading chemical geologists of the day. While humble students were anxiously looking to these great authorities for some land-marks to guide them through the intricacies of the subject; some generally received principle which all would agree to whatever might be the differences of opinion in details, they were more than ever bewildered by finding their two mentors strongly opposed to one another on at least one important point.

And now we must notice one or two weak points in Prof. Huxley's defence,—masterly to a degree, when we reflect that geology is not its author's special study. He has attempted to meet Sir W. Thomson's charge by shewing that the total thickness of the stratified rocks might well have been deposited within the period to which Sir W. Thomson wishes to tie down geologists. But the stratified rocks do not represent the whole, probably nothing like the whole, of geological time; there are the unrepresented breaks to be taken into account. But, as Prof. Huxley himself remarks, Sir William Thomson's limits are so elastic that they might be found wide enough to take in the whole, both of represented and unrepresented geological time. It is with the greatest diffidence that we venture to differ from Prof. Huxley on a point of biology, but we had certainly never imagined that "the *only reason* we have for believing in the slow rate of change in living forms is the fact that they persist through a series of deposits which geology informs us have taken a long while to make." We had always imagined that our own experience assured us that the rate of change in living beings is now, and therefore probably always was, slow; and that the notion of the great length of geological time, which had previously been arrived at on other grounds, was strengthened by a knowledge of this fact. We have noticed these little matters, not because they *really* weaken the case for the geologist, but because they seem to shew a tendency to give in where no concession is needed: Prof. Huxley's answer is to our mind complete, and amounts to this, that these accusations against geology fall to the ground, unless those who bring them forward are admitted to be in possession of all possible knowledge, in short, to be omniscient. To take the one case of the sun; are we sure that we know every possible source from which his heat may be derived? No one would say yes to such a question; but if only one source has escaped us, all our calculations are falsified. Nor can we neglect the possibility of the circulation and return, in some way not yet found out, of heat which these speculations assume is lost to us for ever.

All geologists will render their hearty thanks to Prof. Huxley for the masterly way in which he has conducted their case, and not a few, we suspect, will rejoice that, in upsetting the somewhat arrogant claims of one of the leading Evolutionists of the day, he has unwittingly furnished another proof that the time is not yet ripe for us to look upon Evolutionism as a desirable companion for what we have called Geology.—M.A.

II.—Reliquiæ Aquitanicæ, being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy, Edited by Prof. Thomas Rupert Jones, F.G.S., etc. Part VIII. April, 1869. 4to. London: H. Ballière.

We are glad to see another part of this valuable work, containing a further instalment of the description of the Cro-Magnon Fauna and the Human Skulls and Bones found in this most interesting cavern. M. Lartet remarks that the Saïga Antelope remains—of which, however, only the horn-cores have been met with—are never found except in those stations which had been occupied by the makers and users of barbed arrow-heads, and where the Reindeer predominates. The horn-cores of the Saïga Antelope have been met with in six or seven different localities, always isolated, but not a fragment of a jaw, or detached teeth, or any fragments of limb bones referable to the Saïga, have been found.

"How then," writes M. Lartet, "can we account for the frequent occurrence of the horns of the Saïga in the caves of Central and Southern France, and of no other portion whatever of the animal's skeleton, except by supposing that the long, solid, and pointed horns of the Saïga constituted a formidable weapon, which the Reindeer-hunters of Périgord probably obtained by barter, or commerce of some sort from the people with whom this Antelope was indigenous?"

Of the human skulls and bones found in the cave of Cro-Magnon, near Les Eyzies, Prof. Paul Broca observes: "No discovery could be of greater interest to Anthropologists than that of these bones. "It is the complement, I may say the crowning of the important discoveries made by M. Edouard Lartet and his lamented collaborator Henry Christy, in the Caves of Périgord, especially in that of Les

Eyzies. The objects found in these Caves, not only furnished us with the most satisfactory proofs of the contemporaneity of Man and the Mammoth, but they revealed the most curious details of the life and manners of the old Cave-dwellers of Périgord; still we were without any knowledge of the anatomical characters of this intelligent and artistic race, whose clever carvings are objects of our astonishment.

"The excavations lately made near Les Eyzies, by M. Louis Lartet, enable us to supply this want; and there cannot be any doubt of the authenticity and high antiquity of the human bones there exhumed."

M. Broca is of opinion that the human remains found at Cro-Magnon are not only "as old as, but even perhaps older than the carved objects from the great Les Eyzies Cave. The latter correspond with the period when the Reindeer predominated in the fauna; whilst the former belong rather to the period of the Mammoth; and though a considerable time must have elapsed between the two periods, yet there is nothing to hinder the belief of the gradual passage from one to the other, without any ethnic revolution, the same race maintaining itself in the same district uninterruptedly; so that, if the bones from Cro-Magnon are not those of the artists of the Reindeer Period, they are at least those of the ancestors of that people."

Notwithstanding the great antiquity of these remains, on contrasting them with skulls and bones of the limbs from the Belgian Caves, belonging, no doubt, to an equally remote race of prehistoric men, M. Broca is struck with the marked distinctness of type which they present. "They differ from each other," observes Prof. Broca, "as much at least as modern races differ from one another." M. Broca evidently considers this to be a strong argument against the unity of origin of mankind; but to us it only seems to prove that of which geologists at the present day are becoming more and more convinced, namely, that our ideas of time being all derived from and limited to the records of historical events of civilized races, we are unable to conceive justly the relative duration of the existence of savage races of mankind previous to the period when they were brought in contact with the disturbing influences of even a semibarbarous civilization. So that it will be found, as our knowledge of the Quaternary epoch increases, so will our estimate of the duration of time over which it extended increase.

We have in the plates, accompanying this part, illustrations of oval and round Mortar-stones and Rubber-stones, used probably in the preparation of food or in finishing the manufacture of stone or bone implements. Also figures of flint implements and scrapers, and perforated Reindeer's horns which may have formed parts of sledges.

This work, when completed, will prove, like the Christy Collection, which it illustrates, a most valuable contribution to pre-historic archæology and alike interesting to French and English ethnologists.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—April 28th, 1869.—Papers read: 1. "On the Geology and Mineralogy of Hastings County, Canada West." By T. C. Wallbridge, Esq. Communicated by Dr. Percy, F.R.S.

Before describing the gold and iron-ores of Hastings, which formed the main subject of this paper, the author introduced a general sketch of the geology of the county. After noticing certain local deposits of recent origin, he described the extensive accumulations of Drift-gravels and Boulder-clay. A single boulder near the Shannonville railway-station was said to cover an area of about 5 acres, and to have a thickness of 100 feet. The evidences of glacial action over the whole country were referred to, and the direction of ice-marks cited from several localities. Below the Post-tertiary deposits the rocks consist, in the southern townships, of Lower Silurian limestones, referred for the most part to the Trenton group; and in the northern townships of a large series of metamorphic rocks, supposed to be of Lower Laurentian age. Bosses of syenite and gneiss penetrate the Silurian beds to the south of the main Laurentian mass, and several outliers of Trenton limestone point to the former extension of the Silurian rocks northwards. All the minerals of economic value are confined to the Laurentian area.

Gold was first discovered in the county of Hastings in 1866. The author described in detail the singular occurrence of the metal at the Richardson Mine in Madoc, where it was found in two pockets associated with a peculiar black carbonaceous substance, a ferruginous dolomite, and ochre-brown iron-ore. Assays of the surrounding rocks showed the existence of gold even at a considerable distance from the mine. Mention was also made of several other gold mines in Madoc, Marmora, and Elzevir, from which specimens were exhibited, and analyses of ore quoted.

The iron-ores of Hastings occur partly as magnetic oxide and partly as hæmatite. In addition to the well-known "Big Ore-bed" and the "Seymour-bed," the writer called attention to some new localities of magnetic ore in Madoc. The deposit of hæmatite called the "Kane Ore-bed" was discovered by the author some years back; and from ancient workings in this bed (apparently those of the Indians, who may have used the ochre as war-paint) he has obtained bone-needles and other objects of human workmanship. Attention was then directed to a large deposit of specular iron-ore in Hungerford, hitherto undescribed, and to the pyrrhotine or magnetic pyrites of Madoc.

The paper concluded with a notice of the galena and other less important minerals of the county.

DISCUSSION.—Prof. Ramsay inquired as to the proof of the existence of so large a boulder as one of five acres in extent. Under ordinary circumstances large boulders fell from higher rocks on to the surface of glaciers beneath, and were by them transported to the places where now found; but the fall of such a mass seemed almost incredible. He suggested that possibly it might be an outlier of the Lower Laurentian beds.

Mr. David Forbes stated that the results of his own examination of some of the specimens from the gold mines of this district did not quite tally with those recorded in the paper, especially those of the rocks in the neighbourhood of the veins. He considered that the gold in Canada was confined to the veins.

Mr. Prestwich cited the discovery of a boulder between Stamford and Peterborough, which was at least 400 feet in length, and consisted of a mass of Great Oolite.

Mr. Searles Wood mentioned a boulder of marl in the coast section near Cromer upwards of 300 yards in length and 60 feet in height.

Mr. Wallbridge, in reply, stated that the rock must have come at the least twenty miles from its original home. The surface of the Trenton limestone rock in the neighbourhood was striated in the direction of the boulder. There was no evidence of intrusion. The mass was traversed in two or three places by crevices.

2. "On the distribution of Flint Implements in the Drift, with reference to some recent discoveries in Norfolk and Suffolk." By J. W. Flower, Esq., F.G.S.

The author noticed some recently discovered localities in the valley of the Little Ouse which have yielded Flint Implements, viz. at Broomhill, about 350 feet from and five or six feet above the level of the river; at Gravel Hill, about one mile from, and ten feet above the river; at Shrub Hill, about one mile from, and only a foot or two above the river; and at Lakenheath, nearly three miles from the river, and sixty feet above it. In the first three of these localities the worked flints are in coarse gravel, resting immediately on the Cretaceous beds (Chalk in the first and second, Gault in the third), and overlain by regular deposits of gravel and sand. The implements resemble those of Acheul, Thetford, and Salisbury, but present some peculiarities, from which the author inferred that each place had its own workmen, and that the different forms were intended to answer different purposes. At Brandon implements formed of quartzite were found in a bed consisting of rounded quartzite pebbles mixed with about one-fourth of flints. Flint implements occurred beneath this bed.

The author indicated the geographical characters of the district and the peculiarities in the distribution of the flint implements, which he regarded as in accordance with the phenomena presented by the valley of the Somme; and he argued from the consideration of all the facts that the implements were not transported to their present situation by the agency of the rivers in whose valleys they occur, but that they were made upon the spot, exposed upon the surface with the gravels with which they are found, and from which they were made, and finally covered up by the river-gravels and sandy beds which now overlie them.

Discussion.—Mr. Prestwich dissented from the author as to many of his conclusions. There were in the district drained by the River Ouse beds of gravel belonging to the Boulder-clay series, from which the quartzite pebbles described might have been derived. The author had not taken into proper account the formation of the valleys by erosion, and it was a mistake to suppose that others had not also attributed the formation of the implements to the close proximity of the spots in which they are found. The implements were not limited to the lower part of the gravel, though principally occurring there, but occurred even above the seams of river shells. He inquired whether the gravel between the Little Ouse and the Wissey might not belong to the Boulder-clay series.

Professor Ramsay agreed with the author that flint implements might be found in other localities than those in the neighbourhood of rivers. He protested against referring the gravels to the rivers as they at present exist. The ancient rivers had no doubt run at far higher levels than at present. Even the watersheds afford no gauge of the ancient bounds of the rivers.

Mr. Evans stated his belief that the gravels on the plateau between the Little Ouse and the Wissey belonged to the Glacial series. He could not agree with the author in limiting the occurrence of the implements to the base of the beds, in ignoring the eroding power of rivers, nor in regarding the deposits at Lakenheath and Vaudricourt as remote from all possible river-action. He maintained that the whole of the phenomena were in accordance with the excavation of the valley, since the highest beds with implements had been deposited near Brandon, and pointed out that a large part of the great plain of the Fens had probably been formed principally by tidal action, since the deposit of the gravel-beds at Shrub Hill.

Mr. Searles Wood did not think that the valleys of the district under consideration had been formed by river-action. Some portion of the upper valleys of the Thet and Little Ouse were intraglacial, and possibly they might be partly due to tidal action.

Mr. Flower, in reply, could not accept the belief that the process of the manufacture of these implements could have been carried on during a lengthened period, or other traces of the men who formed them would have come to light. He still thought the French theory of diluvial action was the most in accordance with the phenomena.

II.—May 12th, 1869. 1. "On some of the results arising from the bedding, joints, and spheroidal structure of the Granite on the Eastern side of Dartmoor, Devonshire." By G. Wareing Ormerod, Esq., M.A., F.G.S.

After noticing the apparent bedding of the granite, the author stated that in various places, as at Scarrey and Bolstone Tors on the north, Kestor and Middleton near Chagford, Blackingstone near Moreton, and Houndtor near Ilsington, the beds dipped, and the contour of the country was there caused by these curves. The joints ran in directions mostly from N. to S. and E. to W. The N. and S. joints were generally nearly perpendicular; the E. and W. often inclined to the N. or S. Descriptions of the chief forms of joints and peculiarities connected with them were given; and it was stated that decay acted along these lines, and that to them the forms of the Tors may be traced. Examples were given showing the effect of joints in the large massive Tor and in the insulated rock pillar. A spheroidal structure was shown to exist in the coarse granite south of the Teign, and the possible connexion of the Rock Basins with it was noticed. Various localities were mentioned where the structure was to be seen in cuttings, and in masses like boulders but actually *in situ*. To this cause the form of rounded insulated rocks was attributed. In conclusion, the author stated that these three causes had acted frequently together, and that he considered that to them the origin of the Logan, or Rocking-stones, was often to be attributed. The Logans at Belstone and Thornworthey he attributed to the action of these three causes; and that at Rippon Tor to bedding and joints. The Drewsteignton Logan he considered as a transported block, and the "Nutcrackers" at Lustleigh as a rock, which had rolled down from the high ground above.

DISCUSSION.—Prof. Ansted had observed similar conditions in Leicestershire, Alderney, and elsewhere. The most important feature in the case was the amount of subaerial disintegration and denudation to which the rocks, and especially the Tors, bore witness. The bedding pointed to the metamorphic character of granite; and in some parts of Corsica this was still more plainly evinced than in Devonshire.

Mr. W. W. Smyth agreed that the disintegration of granite was mainly due to the causes pointed out by the author. He did not, however, regard them as *entirely* resulting from subaerial denudation acting on a surface of uniform quality. There was probably a difference in the proportions of the constituent parts in the granite, some parts in the same quarry being soft, while others were of extreme hardness. These softer parts were easily removed, while the harder parts were left. The question was, whether this difference was the result of the original deposition or of subsequent segregation. Even where china clay resulted from the decomposition of the rock, some of the nodules of harder granite occurred.

Prof. Brayley had observed similar spheroidal structure in other crystalline rocks, and had called attention to the subject some years ago. The phenomena at Karn Brê in Cornwall were much the same as on Dartmoor, and resulted from the concealed concentric spheroidal structure of the rock, or what he might term spheroidal tension. In Leicestershire syenite, Rowley Rag, and Northumberland basalt the same was to be traced. He regarded it as the result of slow cooling.

Mr. Scott had observed similar tors in the neighbourhood of Dublin; and on examination of smaller blocks, each was found to contain a nucleus coated with a sort of crust, formed principally of black Mica. In the stratified granites of Donegal such nuclei did not occur.

2. "Notes on apparent Lithodomus perforations on the Hills of North-west Lancashire." By D. Mackintosh, Esq., F.G.S.

The author described certain perforations discovered by him in the limestone rocks near Morecambe Bay at altitudes varying from 200 or 300 to 667 feet above the sea. He stated that the course of these perforations seemed to be irrespective of any differences in the hardness of the rock, and hence, and from the regularity and smoothness of the cavities, he argued that they could not be the result of the chemical and mechanical action of the atmospheric moisture. The perforations were said to occur chiefly in groups, often ramifying from a common entrance, and where the actual entrance is preserved this is narrower than the more deeply seated portions. The author maintained that the hollows described by him had been *ground* out of the rock, and he expressed his belief that they were made by some animal when 'the land was submerged to the extent indicated by the altitutes at which they occur.' From their position he supposed their formation to have taken place during, or immediately before, the Glacial epoch.

Discussion.—Mr. J. Gwyn Jeffreys remarked that Mr. A. Tylor had already called attention to the same subject three years ago. He could not agree in regarding the marking as lithodomus borings. The borings of *Saxicava* and *Gastrochæna* were not parallel, but enlarged towards the base into a pear-shaped form. They were also comparatively straight, and not curved or bifurcated, as in the limestones exhibited. The range in height was also against their being the work of marine mollusks. He thought the holes were more probably due to atmospheric agency.

Prof. Ansted had seen in the large blocks of the Cyclopean walls of Greece, holes of various sizes, bored to different depths by the combined action of vegetation and atmospheric influences. In some cases these holes were large enough to receive the arm, and were two or three feet in length.

3. "On the Parallel Roads of Glen Roy." By Prof. James Nicol, F.R.S., F.G.S.

The author briefly noticed the two principal hypotheses which have been advanced to account for the formation of these terraces, and asserted his own belief in their marine origin. He rested his argument against the hypothesis of their lacustrine origin chiefly on the ground that if their formation be due to successive periods of repose, alternating with sudden drainings of a lake occupying the present valley of Glen Roy, we ought still to find traces of the violent *dèbâcles* occasioned by these drainings, or of large rivers in the gorges through which the waters must have flowed. The author states that no such appearances presented themselves; on the contrary, he adduced certain characters exhibited by these gorges, which, he considered, were strongly in evidence of long-continued sea-action, and seemed to indicate that the gorges in question had been occupied, at the time of the formation of the terraces, by arms of the sea.

Discussion.—Mr. J. Gwyn Jeffreys regretted that no organic remains had been found in these beaches.

Mr. Evans agreed with the author as to the difficulties presented by the Lake theory in accounting for the terraces, especially those not in Glen Roy itself, but in the valley of the Spean. He called attention to the part which sheep and other animals had played in the preservation of the Parallel Roads, the vegetation on which, in consequence of their being more frequented by the animals, was of a different character from that on the other parts of the slope.

Mr. H. M. Jenkins objected to the supposition of the sudden alteration in the level of the water adopted by the author. He thought the gradual sinking of the water was quite compatible with the formation of the roads. He instanced the formation of terraces in gravel-pits filled with water.

Sir H. James announced that the Ordnance Survey of the district in question was now complete.

4. "On Beds of supposed 'Rothliegende' age, near Knaresborough." By J. Clifton Ward, Esq., F.G.S.

The author called attention to certain beds occuring in the neighbourhood of Knaresborough, especially at Plumpton, either of a coarse and conglomeratic structure, or consisting of sandstones or sandy shales. These beds have been regarded by some as belonging to the "Rothliegende" series; by others as belonging to the Millstone Grit. The chief arguments in favour of their belonging to the Millstone-Grit are, as stated by the author:—1. Their similarity to true Millstone Grit beds; 2. Their occurrence in a Millstone-Grit area; 3. Their conformity to the underlying Millstone-Grit rocks, and the unconformity of the overlying Magnesian Limestone; 4. Their containing plant-remains similar to those of the Millstone-Grit; 5. Their colour. Their purplish tint, and resemblance to certain German "Rothliegende" conglomerates, are the only characters which seem to unite them with beds of that age.

Edinburgh Geological Society.—The ninth ordinary meeting of the society was held on Thursday, the 1st April. James Powrie, Esq., F.G.S., Vice-president of the Society, in the chair. An elaborate paper on "The Earliest Vestiges of Vertebrate Life" was read by Mr. Powrie, of which the following is an abstract:—The author stated that the earliest vestiges of vertebrate life had been found in the Upper Silurians of England, consisting of imperfect fragments of fishes. In the Upper Ludlow and Downton beds, and Lower Old Red Sandstone of Hereford, etc. *Pteraspis*, *Cephalaspis*, and remains of Acanthodean fishes were by no means uncommon, but these always in such an imperfect state that the nature and relations of the fishes to which they belonged could scarcely be ascertained. Much light, however, had been thrown on these, the most ancient of known fishes, from the discovery, in the Lower Old Red Sandstone of Forfarshire, of a bed of very great extent, consisting of various coloured semi-calcareous shales, with imbedded nodules, which contain remains of Crustacea and Fishes in very considerable abundance, and from which very complete specimens had been obtained of fishes belonging to the families *Cephalaspidæ* and *Acanthodidæ.* Little notice was taken of the cephalaspid fishes, as a monograph of this family, by Mr. E. Ray Lankester, was in course of publication by the Palæontographical Society; but of the various genera and species of the latter lengthened descriptions were given. Five genera of that family, namely, *Acanthodes*, *Diplacanthus*, *Euthacanthus*, *Ponexin*, and *Climatin*, yielding twelve species, were stated to have been found in the Forfarshire sandstones. In addition to these, a solitary specimen of a fish was described, which was shown to have little or no affinity to any known family of this class, whether recent or fossil. The name *Cephalopterus Pagei* was assigned to it, and a new family suggested for its reception, to be called *Cephalopteridæ.* In conclusion, the high class these olden fishes held in the scale of organic existence was pointed out, in many respects approaching to the Placoid order, to which the modern shark belongs, and which, if high organization and great adaptability for the element in which the animal moves mark rank, must stand very high indeed amongst fishes. The *Acanthodidæ* are perfect fishes of their kind, classing even higher than the average of those which are found in the waters of to-day; and that, in no respect, approximating to any of the other orders of vertebrate life, they gave small reason to believe in a common origin for all; and in this respect that they agreed with the varieties of animal life of that very ancient period. Not only all the great divisions, but even the various classes of animals, being as distinct then as now, and that no intermediate forms could yet be shown to have existed.

GEOLOGICAL SOCIETY OF GLASGOW.—The ordinary meeting was held on the 1st of April. The Rev. Henry W. Crosskey, F.G.S., Vice-President, in the Chair.

The following papers were read:—

I. "On the action of organic matter on peroxide of iron, as observed in the Post-Tertiary sands of Glasgow." By Mr. J. Wallace Young. Mr. Young's observations were the result of a visit to the excavations for Stobcross docks, and the following summary, in part only, may prove interesting to chemical geologists: 1. Underneath a few feet of ordinary brown river sand, containing hazel nuts and fragments of decayed wood, a dark-coloured bed of sand, charged with decaying vegetable matter, was found, which, when treated with an acid, gave off sulphuretted hydrogen, resulting, he believed, from sulphide of iron. The sulphur and sulphuric acid were estimated in the usual manner, and were:—Sand dried at 100° C., sulphuric acid, ·10 per cent.; sulphur, 1·49 per cent. The sulphuric acid would be equal to ·21 per cent. of gypsum, and the sulphur equal to 4·09 per cent. of the monosulphide of iron. 2. A portion of a large oak tree, which had been turned up, gave a water solution containing free sulphuric acid and sulphate of iron, probably derived from oxidation of sulphide of iron by exposure to the air. The presence of sulphide of iron may be explained by the reducing action of decaying organic matter on peroxide of iron and sulphate of lime—carbonate of iron and sulphide of calcium being first formed, and then immediately decomposed into sulphide of iron, which has remained, and carbonate of calcium which had been removed. 3. Some tabular concretions, concentrically disposed around twigs, were found to be composed of sand and clay cemented together by peroxide of iron. Two specimens gave respectively 29·97 and 25·14 per cent. of peroxide of iron. The origin of these tubes the author considered to be due to the decaying of the vegetable tissue of the twigs, leaving small holes through which water had carried down iron in some form or another, and gradually cemented together the surrounding sand and clay. On breaking open many pieces of the brown clay, they were seen to be perfectly crowded with holes, some merely surrounded with a stain of peroxide of iron, and in all stages up to the perfect tubes. The iron in the surrounding clay appeared to be equally distributed throughout, so that the excess of iron oxide had been added, he believed, in the manner indicated, and not by segregation from the surrounding matrix.

II. "Notes on the Post-Tertiary Geology of the Carse of Falkirk." By Mr. John Burns. The author gave an interesting account of the superficial deposits of the district, derived from an examination of several exposed sections, and from the records of the beds passed through in boring, and by the sinking of shafts for the working of minerals; his views being, in general, confirmatory of those entertained by Messrs. Croll and Bennie as to the existence of a great trough between the valleys of the Clyde and the Forth.

III. "On the succession of the Post-Tertiary beds beneath the Boulder-clay at Kilmaurs." By Mr. John Young. In the course of his remarks, Mr. Young stated that ever since the discovery, in the year 1816, of the remains of the Mammoth, *Elephas primigenius*, at the Woodhill quarry, Kilmaurs, these beds had attracted the attention of nearly every writer on Scottish Post-tertiary geology. Since the period of the first discovery, some nine or ten tusks, and a portion of a molar tooth had been found, also some horns of the Reindeer, *Cervus tarandus*, preserved in the Hunterian Museum with two Mammoth tusks. These remains were at first referred to the Boulder-clay. Dr. Bryce, a few years ago, however, having become satisfied of the unfossiliferous nature of this deposit as it exists in the West of Scotland, made an examination of the Kilmaurs beds, and from information obtained from parties who had formerly worked in the old quarry, and from a section opened up for him, he was able to show clearly that the remains of the Mammoth and the Reindeer were not found in the Boulder-clay, but in certain thin beds underlying the Till, and superimposed upon the Carboniferous sandstone of the Woodhill quarry. In Dr. Bryce's paper, with section, showing the order of succession of the beds, published in the Quarterly Journal of the Geological Society of London for 1855, it is stated "that several species of marine shells had been found along with some of the tusks," but as these had never been correctly identified the age of the beds had always remained doubtful, and the relations of the "Mammoth" bed to that containing the marine shells was involved in a certain amount of obscurity, which recent discoveries had only enabled the author fully to clear up. From the researches of Mr. Craig, however, and the discovery in the beds of two sets of organisms of different origin and age, such as those exhibited, he was able to show their exact relation; and the evidence thus gained beyond what was formerly known goes to prove that the Carmel was a valley in Pre-glacial times, in which roamed herds of Reindeer and the hairy Mammoth, and that some of these have left their remains in certain estuarine deposits formed over the lower levels of the valley. The next evidence is the depression of the valley, with its estuarine beds, under sea level, as clearly indicated by the bed of sand with marine shells of Arctic types, marking as it were, by their presence, the dawn of the Glacial period. Mr. Craig had also obtained evidence, from other pits and bores sunk in the valley, that the marine sand and estuarine beds had suffered denudation at several points before the Boulder-clay and upper drifts (50 feet in thickness) were deposited above them, the Boulder-clay at these points resting upon the Carboniferous sandstone of the district. Mr. Young concluded his remarks by stating that he could not give a decided opinion at present as to the exact age of the "Mammoth" bed at Kilmaurs, but the evidence seemed to point it out as a Pre-glacial remnant of the oldest Post-tertiary strata yet discovered in the West of Scotland. J. A.

CORRESPONDENCE.

THE SOUTH COAST OF FURNESS.[1]

Sir,—In Mr. Maw's article in the February number of the Geological Magazine, he does not mention a whitish-grey sandy clay which emerges through the beach gravels about high-water-mark between his two cliffs. The same clay (four years ago) could be seen at intervals for two miles along the east shore; and about that distance from Rampside, I found it, in cutting down to the shell-beds, 200 yards inland, six feet below the surface. On the west shore, near the next cliff, a little over a mile from Rampside, it is bluer, and of a rather more soapy nature, containing smoothed pebbles, a little striated.

I fail to see anything new in Mr. Maw's notice of the shell-beds, except it be in his having carried them to the top of the cliff, a height of more than forty feet (see his Fig. 2, *a*). This is interesting, if intended to signify the fact, as I had not ascertained that they anywhere rose above the 25 feet contour. I had certainly observed that grass-sods falling from above, were charged with minute shells, but I judged they might have been carried over the head in storm-spray.

With respect to the age of our Furness shell-beds, I had hoped that the very carefully drawn up list of species given by me on page 216 of the last Number of the Geologist, 1864, and reprinted in the North Lonsdale Magazine, 1866, would have sufficiently indicated their Post-glacial character: not one arctic shell being there recorded. That list is not a long one, and perhaps it might be augmented: still, owing to their comminuted state in many places, it was a work of time and trouble; and if it be, as I have believed it to be, the only one published, it is not without a certain value. I am of opinion that the Bay of Morcamb[1] is a much less ancient inlet than the Frith of Clyde, and the Kyles of Bute, where Mr. Smith, Mr. Sowerby, my revered friend Dr. Landsborough, and numerous acute observers have worked so successfully: the coeval shore line of this part of Britain, viz. Cumberland and Lancashire, doubtless stood a long way further out. E. Hodgson.

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[1] Owing to want of space last month this and the following letter were unavoidably postponed.—Edit.

Ulverston, *15th March.*

"GEOLOGICAL NOTES FROM NORWICH."

[Proceedings of the Bristol Naturalists' Society, Vol. iii., Nos. 7, 8, and 9, 1868. Noticed in Geological Magazine for April, p. 177.]

Sir,—Permit me to reply to the somewhat stringent remarks of H. B. W. in your last number, and to suggest that it would have been much kinder if H. B. W. had ascertained whether the short abstract were a correct *resumé* of the original paper.[2]

The different statements made at Norwich respecting the geology of that county were so conflicting and contradictory as to call forth a remark to that effect from the President of the Geological section (see *Norfolk News*, Aug. 22, 1868). So puzzling were they that I, in common with many others, felt really "out of my element," and "at sea," and therefore had recourse to "literature" for information to which also I would refer H. B. W. For instance, I found that the Norwich beds are said to have been seen to directly overlie the Red Crag at Chillesford (*vide* Elem. Geol. pp. 196, 198). Again, the same authority states that the Bridlington beds have about the same age as the Chillesford (*loc. cit.* p. 198).

With regard to my statement respecting the *Potamides*, I still see no reason why they should not be that sub-genus, nor can I discover any difference between the Bramerton shells and many that I obtained from the fluvio-marine beds of the Isle of Wight. The shells of the *Potamides* cannot be distinguished from the *Cerithia* (*vide* Wood's Crag Mollusca, p. 68) in their conchological character, but the former lived in estuarine or freshwater, while the latter lived in marine habitats.

With the Bramerton fossils are found some freshwater shells, and therefore the conclusion that they were *Potamides* is a very likely one.[3] Mr. Wood also makes a statement to that effect (Crag Moll. p. 68). Sir Charles says (Elem. p. 196), "It is clear that these beds have accumulated at the bottom of the sea near the mouth of a river."

With regard to the antiquity of the Red Crag, I simply stated that the Red Crag was the oldest Pliocene formation, *with which I had then to do*, and H. B. W. may fairly have conjectured this, for, probably, there are few to whom the Coralline Crag is not familiar.

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[1] This is written Morcamb in Beck's work "Annales Furnesiensis," the best work we have.—E.H.

[2] We are exceedingly sorry to learn that the Bristol Naturalists' Society are in the habit of issuing their Proceedings without first consulting authors whose papers they intend to publish, and obtaining their corrections to the same. We would earnestly recommend Mr. Stoddart in future to insist upon seeing and revising his own papers before publication, in whatever Journal they may appear.—Edit.

[3] *Potamides* does not occur in the Norwich Crag.—Edit.

In conclusion, if H. B. W. should ever visit Bristol, I shall be happy to show him my *Potamides,* and elicit his opinion.

7, King Square, Bristol. W. W. Stoddart.

RUGBY SCHOOL NATURAL HISTORY SOCIETY.

Sir,—In your kind notice of the Rugby School Natural History Society's Reports, there are one or two errors of some importance. Will you allow me to correct them? A quotation is made from a report very much out of date, and it is made to appear as if applicable to the present system. As it is, very nearly the whole school, and not one-tenth only, are at work at Natural Science, and have been so for five years. The central study is Chemistry, this is connected on the one side with Natural History, of which Botany and Geology are selected as types; and on the other side with Physics, that is, with us, with mechanics, and heat, and electricity.

Many of your readers would be interested, I think, in seeing how laborious young observers are in botany, and how much is found to provide them with original work.

I must disclaim the honour of being President. This post is most worthily filled by Mr. Kitchener, M.A., F.L.S., to whom the Society is greatly indebted. James M. Wilson.

Rugby, *May* 8, 1869.

P.S.—One of my young geologists, Mr. H. C. Cholmondeley, tells us of a singular subsidence at Marton, near Northwich, on Lord Delawarr's property. About twelve years ago a circular area, sixty yards across, suddenly sank down, to a depth, as I understand, of a few yards. Two years ago a fresh subsidence took place, sufficient to submerge a poplar tree, which remained standing in the circular lake so formed. Last term the ground again sank, and the sinking was accompanied with much noise, and violent movement of the water. The water was cold. It is four miles to the nearest salt mine, and three to the nearest brine works. He is unable to assign any cause for the phenomena. Perhaps some of your Cheshire correspondents can enlighten us.—J.M.W.

THE GRAVELS OF LOPHAM FORD.

Sir,—I think it important that the phenomena at Lopham Ford should be fully discussed, on account of the light they are calculated to throw upon denudation. I am glad, therefore, that my esteemed friend has not allowed my reply to his query to pass without remark, for I hope the question he raises may induce Geologists to go and see for themselves and report to you. I should not have referred again to the subject, because I have said my say, and stand by my opinion. But Mr. S. V. Wood, jun., has kindly and spontaneously written to me, to tell me that he visited the spot with Mr. Harmer, while they were engaged in mapping the glacial deposits, and that he agrees with me that the gravel south of Lopham Ford is Middle Drift, and not a river-gravel. O. Fisher.

P.S.—*Erratum* at p. 552, line 42, vol. v. 1868, for "Boulder-clay" read "London clay." O.F.

THE
GEOLOGICAL MAGAZINE.

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ORIGINAL ARTICLES.

I.—THE CRYPTOGAMIC FORESTS OF THE COAL PERIOD.

By WILLIAM CARRUTHERS, F.L.S., F.G.S., of the British Museum.[1]

THE student of fossil botany encounters greater difficulties in his efforts to restore the vegetation of former epochs in the earth's history, than those which beset the labours of the comparative anatomist in his restoration of extinct animals. These difficulties arise chiefly from two causes: First, the absence in the vegetable kingdom of a substance which would resist decay like the solid skeleton found in all the vertebrate, and in many of the invertebrate members of the animal kingdom, causes the fragments of plants which have escaped decomposition to be preserved much less perfectly than the remains of animals. Carbonaceous stains or amorphous casts are the most frequent indications of the former vegetation of the globe; specimens exhibiting structure are comparatively rare; and it is such specimens only that give certain evidence of the nature and affinities of the organisms to which they belong.

The other serious source of difficulty arises from the fact that no relative proportions exist among the different parts of a vegetable individual. The size of the leaf, the flower, or the fruit, can give no indication of the size of the plant. Indeed, these are more frequently found large in humble plants which never rise above the surface of the ground than in large trees. And this is true, not only in the general, but even among members of the same natural group; where great differences exist in the size of the individuals, no corresponding differences are to be found in the parts of which they are composed. Thus the foliage and fruit of our only indigenous pine—the Scotch fir—are greater than those of the mammoth *Wellingtonia* of California; and the fruit of the small willow (*Salix herbacea*, L.), which covers with a dense carpet the summits of some of the higher mountains of Scotland, is as large as that of the huge willows which ornament the margins of our English rivers. On the other hand, the different parts of an animal possess such relations to each other in size, form, and structure that a zoologist has not so difficult a task before him in restoring, even from imperfect materials, the general aspect of an extinct animal.

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[1] Being the substance of a lecture delivered before the Royal Institution of Great Britain, at the Weekly Evening Meeting on Friday, April 16, 1869, Sir Henry Holland, Bart., M.D. D.C.L. F.R.S., President, in the Chair. The Illustrations have been kindly lent by the Council, together with permission to reprint this valuable contribution to Fossil Botany.—EDIT.

I state these difficulties which face us at the very threshold of our investigations, not to magnify the work before us this evening, but to account for the comparatively little progress that has been made in the interpretation of extinct floras, and for the great diversity of opinion that exists among botanists as to the systematic position of numerous fossil plants; and further to account for the very large number of genera and species which have been established on imperfect and fragmentary materials, the systematic position of which is consequently indeterminable.

The progressive accumulation of observations, and the more careful preservation of instructive specimens in local and private museums are supplying the means of dealing with fossil botany after a different method. The most important recent advances in this science have been made in uniting the separate fragments,—roots and stems, leaves and fruits,—described under different names and placed in different and often widely separated genera, so as to build up vegetable individuals, the systematic position and affinities of which can be understood.

These observations are specially true in regard to the vegetation of the Coal Period. Little information has been obtained from the vast stores of the carbonized remains of the plants of this period which are ever being brought under the inspection of man in the form of coal, for this material is so completely altered as to be almost destitute of structure. The best preserved plants occur in the beds of shale which accompany the coal, or are obtained from earthy nodules in the coal itself, which injure its marketable value, and are consequently got rid of by the miners.

We may at once set aside that great division of the vegetable kingdom with which we are most familiar, comprising all plants that have true flowers and seeds, and confine our attention to the more obscure cryptogamous plants which are destitute of flowers, and for seeds have bodies of much simpler structure called spores. The cryptogams are either wholly cellular in their composition, like the mosses and sea-weeds, or they are composed partly of cells and partly of vessels, like the ferns and club-mosses.

If we except some supposed *Algæ*, no traces of true cellular plants have been hitherto detected in the Coal-measures. The long-continued maceration to which the coal plants were subjected when the beds composed of their remains were forming on the surface of the earth, and the subsequent changes they have undergone, have reduced to one common structureless mass the varied vegetation of which the coal is composed. One of the first results of these operations would be the disappearance of the cellular plants, which under the then existing very favourable conditions must have abounded; just as the soft cellular parts are almost always destroyed of those specimens which have been so favourably situated as to have their vascular tissue preserved.

Excluding then the cellular cryptogams, we may shortly consider the classification and structure of the vascular forms. They are divided into four groups, all of which are represented in the indigenous Flora of Britain.

I. Ferns (*Filices*). Polypody, Brake, Spleenwort, etc.
II. Horse-tails (*Equisetaceæ*). Horse-tail.
III. Club-mosses (*Lycopodiaceæ*). Club-moss and Quill-wort.
IV. Pill-worts (*Marsileaceæ*). Pill-wort.

I. The FERNS have a rhizome which creeps below or upon the surface of the ground, or rises into the air like the trunk of a tree. This trunk in some species attains a great height; it is nearly uniform in diameter throughout its whole length, and is covered with the symmetrical and regularly-arranged markings of the stalks of the old leaves. Internally it is composed of a central cellular pith surrounded by a cylinder of scalariform tissue, and this is invested by a cortical cellular layer or bark.

The woody cylinder is composed of simultaneous vascular bundles, which originate and are completely developed at the same time; there is consequently no addition to it from subsequent growth. It is penetrated by large open meshes, each of which permits the passage of the vascular bundles that supply a leaf, accompanied with a certain amount of cellular tissue from the medulla which occupies the centre of the mesh.

The leaves, which are very variable in size and form, not only perform the functions of ordinary leaves, but also bear the fruit, and are hence called fronds. The fruit is produced in clusters on the back or margin of the fronds; each cluster contains many sporangia, and each sporangium numerous uniform spores.

Though there is a great diversity in the size of the plants of this order—from the humble Wall Rue to the giant Alsophilas,—there is a remarkable uniformity in the size of the spores.

When the spore germinates it bursts through the outer membrane and puts forth a tubular prolongation, which increases by cell-multiplication until a small green leaf is produced, called the prothallus, on the under-surface of which two kinds of glandular-like bodies are developed: the one, the antheridia, containing numerous cells with spermatozoids, the other, the pistillidia, one of which when fertilized develops into a true fern.

II. The HORSE-TAILS have slender, hollow, and jointed stems. Each joint terminates in a toothed membranous sheath, composed of leaves reduced to this elementary state. Whorls of branches and branchlets are given off at the joints in some species.

The fruit is produced in terminal cones composed of numerous stalked peltate scales, each of which bears on its under-surface a circle of sporangia filled with numerous uniform spores. The spores have a spiral covering, which, when they are ripe, breaks up into four clavate threads called elaters, which are remarkably hygrometric.

The spores germinate like those of ferns.

III.—The CLUB-MOSSES have solid stems composed of an axis of spiral vessels, surrounded by a thickish cortical cellular layer. The leaves are simple, and arranged spirally on the stem. The branches are irregular and dichotomous.

The fruit is produced in terminal cones composed of imbricating scales. Each scale bears on its pedicel a small sporangium full of spores. In *Selaginella* two kinds of spores exist. The one, called microspores, produces spermatozoids; the other, macrospores, germinates, and forms a prothallus on which pistillidia appear; and these, when fertilized by the spermatozoids of the microspores, grow into perfect plants. In *Lycopodium* microspores only have been seen, and the process of its germination is still unknown.

The little Quillwort (*Isoetes*) which grows at the bottom of most of our mountain lakes, agrees with *Selaginella* in having two kinds of spores; but it differs from the true club-mosses in its habit and in the structure of the stem. Like *Welwitschia* it never increases in height; but this is even more remarkable in the Quill-wort than in *Welwitschia*, seeing that in it there is, as long as the plant lives, a continual development of nodes with their foliar appendages going on. The axis of the stem is composed of cellular tissue. This is surrounded by a vascular cylinder, which grows, as in exogens, by the addition of external layers, there being in this plant a true cambium layer outside the wood, a structure unknown in other cryptogams.

IV. No plants allied to the PILLWORTS have hitherto been detected in the Coal Measures; we need not, therefore, be detained by an examination of their structure and development.

In examining the palæozoic cryptogams of the Coal Forests, I will follow the same order as that in which we have glanced at their living representatives.

I. The FERNS need not long occupy our attention. They were very abundant, though as a rule they were humble herbaceous plants. Arborescent stems are extremely rare—only two undoubted species have been met with in Britain. The numerous known forms have either grown on the earth, or, as is very probable, been Epiphytes. Fructification is rare; in the few cases in which it has been found it agrees with that of recent ferns. Occasionally young fronds exhibiting circinnate vernation have been met with, showing that this method of unrolling the frond was as characteristic of the ferns of that period as it is of those of the present.

The fern is a remarkably stable type of vegetation. The earliest forms, like the *Cyclopteris Hibernica* of Forbes from the Old Red Sandstone, agrees in all comparable points with the recent plants; and throughout all the intervening space no divergence in any point of importance has been detected.

II. No group of fossil plants can more fully illustrate the imperfect materials with which the palæontological botanist has to deal than that group which I have united under the name *Calamites*.[1] The various parts of the plant—the root, the stem, the leaves, and the fruit—have been formed into numerous genera, which have been referred to widely different positions in the vegetable kingdom.

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[1] On the Structure of the Fruit of *Calamites*. Seeman's Journal of Botany, vol. v. (1867), p. 349, Pl. 70.

Considerable diversity of structure is to be found in those stems which are referred to *Calamites.* I shall ask your attention to one of these forms which I have described,[1] and which is beautifully illustrated by a series of drawings, recently published, of specimens in Mr. Binney's collection.[2] This stem was composed of a central medulla surrounded by a woody cylinder, composed entirely of scalariform vessels and a thin cortical layer. The medulla penetrated the woody cylinder by a series of regular wedges, which were continued, as delicate laminæ of one or two cells in thickness, to the cortical layer. The cells of these laminæ were not muriform; their longest diameter was in the direction of the axis. The wedges were continuous and parallel between each node. As the axial appendages were produced in whorls, the only interference with the regularity of the tissues was by the passing out through the stem at the nodes of the vascular bundles which supplied these appendages. As the leaves of each whorl were (with one or two exceptions) opposite to the interspaces of the whorls above and below, there was also at each node a rearrangement of the wedges of vascular and cellular tissues.

The stem is described as having been fluted on the outer surface. This error had its rise in the specimens examined, being only casts in the amorphous substance of the rock of the medullary cavity, surrounded by a thin film of coal representing the cylinder of wood. On the death of the plant, the cellular medulla decayed, while the woody cylinder was still able to retain its original form. The hollow interior was filled with some of the mud or sand in which the plant was buried. In the course of time this offered greater resistance to the pressure of the beds above than the originally hard cylinder of scalariform tissue, now softened by the moisture in which it had so long lain: the more indurated amorphous axis on pressure necessarily produced its characteristic ridges and furrows on the smooth outer surface of the film of coal. This coal is described as the cortex or bark, and stems exhibiting only the rocky casts of the medullary cavity are called decorticated specimens; but, besides the cortical layer, they have also been deprived of all that remained of their woody tissue.

The stem terminated below somewhat suddenly in a blunt cone, the internodes of which were slightly developed; and from the nodes were given off whorls of large roots, which again gave off innumerable branching rootlets (*Pinnularia*).

The stem or main axis was simple, supporting numerous branches arranged in whorls, which again produced numbers of whorled leaves. Three different forms of leaves have been formed into as many genera. When the structure of the fruits associated with them is better known, by the discovery of better preserved specimens, it is possible they may be found to constitute three genera, but there are no characters possessed by the leaves which prevent them belonging to one well-defined genus.

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[1] On the Structure and Affinities of *Lepidodendron* and *Calamites.* Trans. Bot. Soc. Edin. vol. viii. (1866) p. 495, Pl. 8 and 9.

[2] On the Flora of the Carboniferous Strata, Part I. By E. W. Binney. Palæont. Soc. vol. xxi., 1868.

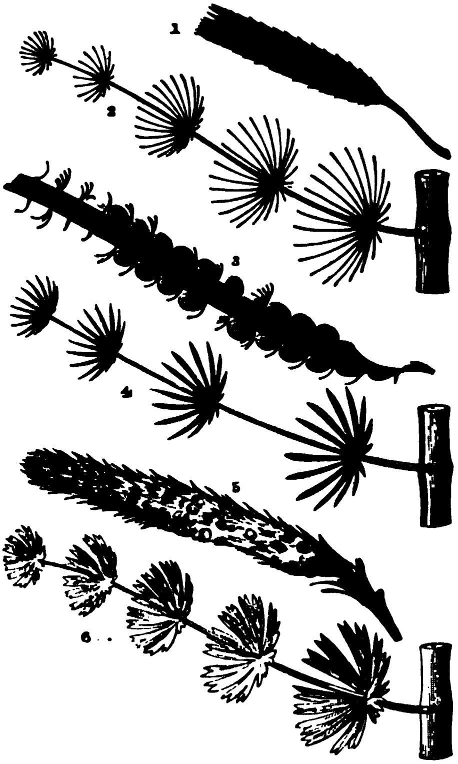

Plate I.—Foliage and Fruits of Calamites.
1 and 2, Asterophyllites; 3 and 4, Annularia; 5 and 6, Sphenophyllum.

The simplest form of leaf (*Asterophyllites*) is slender and linear, with a single nerve. This can scarcely be separated from the form to which the name *Annularia* has been given, and which differs chiefly in having a larger amount of cellular tissue spread out on either side of the midrib. This form has a different aspect in the fossil state from the other, for its whorls of numerous broad leaves are spread out on the surface of deposition, while the acicular leaves of *Asterophyllites* have penetrated the soft mud, and are generally preserved in the position they originally occupied to the supporting branch. The third form (*Sphenophyllum*) consists of whorls of wedge-shaped leaves with one or more bifurcating veins. They occur like those of *Annularia*, spread out on the surface of the shale.

The plan of arrangement of the three forms is the same, and fruits are found associated with them which have the same general *appearance;* but they are so ill preserved that their internal struc-

ture has not hitherto been determined. The different forms ha
been placed together as allied genera, and have been referred, l
those who have specially studied them, to the phanerogamous Ord
Haloragaceæ near to the Water Milfoil (*Myriophyllum*), with son
species of which they agree very remarkably in the arrangeme
and aspect of their foliage and fruit.[1]

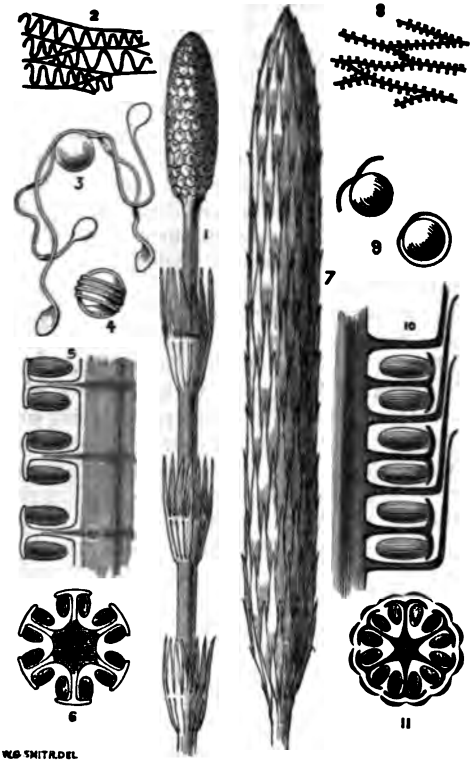

PLATE II.—FRUITS OF EQUISETUM AND CALAMITES.

Fig. 1. *Equisetum arvense*, L. 2. Portion of the sporangium wall. 3. Spo
with the elaters free. 4. Spore with the elaters clasping. 5. Longitudinal secti
of the part of one side of cone with three fruit-bearing scales supporting sporang
6. Transverse section of cone. 7. *Calamites* (*Volkmannia*) *Binneyi*, Carr., magnifi
three times. 8. Portion of the sporangium wall. 9. Two spores, one showing t
bases of two elaters free, the remainder being removed in slicing the fossil, and t
other showing the elaters clasping. 10. Longitudinal section of part of one si
of cone with three fruit-bearing and four simple leaves. 11. Transverse section
cone, showing six fruit-bearing leaves and twelve protecting scales.

The determination of the internal structure of one of these frui
which I made, first from specimens collected by Mr. Binney, ar
have since confirmed from specimens which have been some yea

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[1] Monographie des Sphenophyllum d'Europe. Par E. Coemans and J. J. Kicl
Bulletin Acad. Roy. de Belgique, 2nd Ser. vol. xviii. (1864), No. 8.

in the cabinet of Dr. Millar, has enabled me to refer these fossils with certainty to the cryptogamous Order *Equisetaceæ* as near allies of our living Horsetails.

This fruit, to which I have given the name *Volkmannia Binneyi*,[1] is a small slender cone, composed of whorls of imbricated scales (twelve in each), arranged like the successive whorls of leaves on the branch, so that the scales of one whorl are in a line with the spaces between the scales in the whorls above and below. The scales completely conceal the fruit-bearing leaves. These are stalked and peltate, arranged in whorls alternating with the scales, but having only six—half the number of the scales in a whorl. The sporangia, four in number, are borne on the under-surface of the peltate leaves; their walls are formed of elongated cells, which have in their interior a secondary deposit of cellulose proceeding in short truncate processes from the sides of the cell-walls which are in contact, and having the appearance of an incomplete spiral. The sporangia are filled with simple spherical spores, which in the closely-packed sporangium appear to be furnished with double cell-walls. In the half-empty sporangia the outer wall cannot be detected, but there appear instead a number of thread-like processes proceeding from the spore like the elaters in the living Horsetails.[2]

A comparison of this fossil cone with the fruit of *Equisetum* exhibits a remarkable agreement in every point of importance. In the form of the fruit-bearing leaves, the arrangement and structure of the sporangia, the form, size, and structure of the spores. even to the possession of hygrometric elaters, both fruits agree. The only difference is that in the modern plant all the leaves of the cone are fruit-bearing, while in the fossil every other whorl retains a form closely approaching that of the normal leaf of the plant. As these envelope and protect the fruit-bearing leaves, they may be held to give to the fossil a somewhat higher systematic position than is possessed by the living genus. This superiority is further exhibited when we contrast the complex structure of the stem, and the free leaves of *Calamites* with the fistular and sheath-bearing stems of *Equisetum*.

III. The stems, branches, and fruit of the genus *Lepidodendron*, are so abundant in the shales that cover the coal, that the external aspect of this tree has been for a long time well known. Specimens exhibiting structure are more rare, but these also have been met with, so that we know the internal organization as well as the external aspect of the fossil.[3]

The stem is composed of a central pith surrounded by a slender cylinder of scalariform woody tissue, and by a large cortical layer which is divided into two portions, an inner consisting of large spherical and thin-walled cells, and an outer made up of regularly arranged elongated cells with a small diameter. The vascular cylinder is penetrated by radiating meshes through which the vascular bundles passed that supplied the leaves. The outer surface of the stem is covered with the spirally arranged and beautifully marked stigmata of the fallen leaves. The stem branches repeatedly in a dichotomous manner. The younger branches are densely covered with small lanceolate leaves, having a single median vein.

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[1] Prof. Schimper has more recently described and figured the same fruits under the name of *Calamostachys Binneyana* in his Traité de Paléontologie Végétale, vol. i. (1869), p. 330.

[2] Mr. Binney has beautifully illustrated the structure of the stem and fruit of *Calamites* in a series of drawings from specimens in his rich collection, published by the Palæontographical Society in the end of last year.

[3] On some Fossil Plants, showing structure. By E. W. Binney. Quart. Journ. Geol. Soc. vol. xviii. (1862), p. 106, Pl. 4—6. Phil. Trans., 1865.

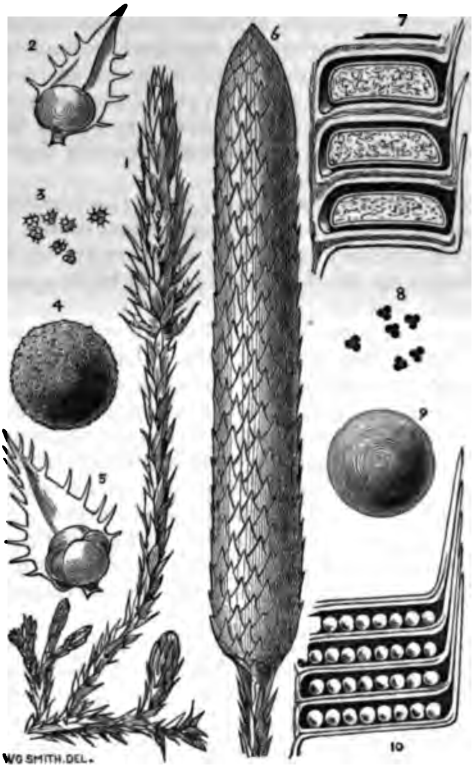

PLATE III.—FRUITS OF SELAGINELLA AND TRIPLOSPORITES.

Fig. 1. *Selaginella spinulosa*, A. Braun. 2. Scale and sporangium from the upper portion of the cone. 3. Antheridian microspores from ditto. 4. Macrospore. 5. Scale and sporangium from the lower part of the cone containing macrospores. 6. *Triplosporites Brownii*, Brongn. 7. Three scales and sporangia of ditto. 8. Microspores from the sporangia of the upper part of the cone. 9. Macrospore from the sporangia of the lower part (drawn from Brongniart's description and measurements). 10. Scales and sporangia of a cone of *Flemingites*.

The fruit is a cone composed of imbricated scales arranged spirally on the axis like the true leaves, and bearing the sporangia on their horizontal pedicels. Three different forms of fruit belong to this genus, or it should perhaps rather be called group of plants.

The first of these is the cone named by Robert Brown *Triplosporites*,[1] and described by him from an exquisitely preserved specimen of an upper portion, in which the parts are exhibited as clearly in the petrified condition as if they belonged to a fresh and living plant. The large sporangia have a double wall, the outer composed of a compact layer of oblong cells placed endwise, or with the long diameter perpendicular to the surface; the inner is a delicate cellular membrane. The sporangium is filled with a great number of very small spores, each composed of three roundish bodies or sporules. Recently Professor Brongniart has described a complete specimen of this fruit,[2] in which the minute triple spores are confined to the sporangia of the upper and middle part of the cone, but the lower portion, which was wanting in Mr. Brown's specimen, bears sporangia filled with simple spherical spores ten or twelve times larger than the others.

The structure of another form of cone (*Lepidostrobus*) has been expounded by Dr. Hooker.[3] The arrangement of the different parts comprising it is precisely similar to what occurs in *Triplosporites;* but the sporangia are filled with the minute triple spores throughout the whole cone.

The third form of cone, which I have described under the name *Flemingites*,[4] differs from the other two in having a large number of small sporangia supported on the surface of each scale; and it agrees with *Lepidostrobus* in the sporangia containing only small spores.

In comparing these fossils with the living club-mosses, one is struck with the singular agreement in the organization of plants so far removed in time, and so different in size, as the recent humble club-mosses and the palæozoic tree Lepidodendrons.

The fruit of *Triplosporites*, like that of *Selaginella*, contains large and small spores, the microspores being found in both genera on the middle and upper scales of the cone, and the macrospores on those of the lower portion.

On the other hand, the fruits of *Lepidostrobus* and *Flemingites* agree with those of *Lycopodium* in having only microspores.

The size of the two kinds of spores also singularly agrees in the two groups. This is of some importance, for among the recent vascular cryptogams there is a remarkable uniformity in the size of the spores in the members of the different groups, even when there is a great variety in the size of the plants. Thus the spore of our humble Wall-rue is as large as that of the giant *Alsophila* of tropical regions. So also the spores of *Equisetum* and *Calamites* agree in size, as may be seen in Plate II., Figs. 3, 4, and 9, where the spores of the two genera are magnified to the same extent. And a similar comparison of the macrospore and microspore of *Triplosporites* with those of *Selaginella*, and of the microspore of *Lepidostrobus* with that of *Lycopodium*, exhibits a similar agreement. This is made apparent by the drawings of the two kinds of spores of *Selaginella* on Plate III., Figs. 3 and 4, with those of *Triplosporites*, Figs. 8 and 9, which are drawn to the same scale.[1]

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[1] Some account of Triplosporite. By R. Brown. Trans. Linn. Soc. vol. xx. (1851), p. 469, Pl. 33 and 34.

[2] Notice sur un fruit de Lycopodiacées fossiles. Par M. Brongniart. Comptes Rendus, vol. lxvii., Aug. 17, 1868.—Translated in Seemann's Journal of Botany, vol. vii. (1869) p. 1.

[3] On the Structure and Affinities of some Lepidostrobi. By J. D. Hooker. Memoirs of Geol. Surv., Vol. ii., Pt. 2 (1848), p. 440, Pl. 3–10.

[4] On an Undescribed Cone from the Carboniferous Beds. GEOL. MAG., Vol. II. *(1865), p.* 433. Pl. 12.

The fossils represented by the group of stems known under the name of *Lepidodendron*, and by the three fruits described, agree in all essential characters with the living Club-mosses, the only difference of importance being that the stem of the fossil has a higher organization suited to its arborescent habit. The vascular tissue continued to increase with the growth of the plant somewhat like an exogenous stem. In all the living vascular cryptogams, the vascular tissue is produced at once in its full extent except in *Isoetes*, which has a cambium layer surrounding the cylinder of wood in which as the plant grows new vascular tissue is developed. The zone of thin-walled spherical cells which surrounds the woody cylinder in *Lepidodendron*, and which is so rarely preserved, has been a true cambium layer like that in *Isoetes*. But for the existence of this small water-plant, the large trees of the coal-forests would present in the growth of their stems an inexplicable anomaly.

Sigillaria, a very abundant Carboniferous fossil, is a member of the same family as *Lepidodendron*. Its stem is rarely preserved so as to exhibit structure, the only specimen hitherto described being *S. elegans*, Brongn.;[2] but its roots are frequently found in a very perfect condition. The name *Stigmaria* was given to the roots at a time when they were supposed to be independent plants. Their relation to *Sigillaria* was suggested by Prof. Brongniart from the correspondence in their structure, by Sir W. Logan from the position the two fossils occupied in the beds in which they occur, and the matter was finally set at rest when Mr. Binney observed the roots and stems in actual continuity.

As the structure and arrangement of corresponding parts in the same plant are uniform, as of the root, stem, branches, and axis of the cone, we may supply the want of information regarding the stem by that which can be obtained from the root.

The root is composed of a central medulla surrounded by a cylinder of scalariform tissue, and this again is invested by a large cellular layer. The vascular cylinder is broken up by meshes through which passed the vascular bundles to the rootlets. There are no traces whatever of medullary rays in the wood. The supposed medullary rays which have been described in *Sigillaria* are the accidental results of desiccation in particular specimens. The internal structure of the stem is precisely the same as in *Lepidodendron*, to which it is closely allied. Externally it has a very different appearance, being either a simple cylindrical column, or in some species dividing dichotomously into a few thick branches. The leaves are long, slender, and parallel-sided. Their scars ornament the older portions of the stem, on which they are arranged in perpendicular series with intervening furrows.

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[1] I have given the precise measurement of these spores in a Notice of some Plant Remains from Brazil. Geol. Mag., Vol. VI. (1869), pp. 153, 154.

[2] Observations sur la Structure intérieure du *Sigillaria elegans*. Par A. Brongniart. Archives du Mus., Vol. i. (1831) p. 405.

The fruit has been described by Goldenberg. It agrees with that which I have described in *Flemingites* except that the small sporangia are scattered in an irregular patch over the dilated base of an ordinary leaf, and this confirms the systematic position which I have given to *Sigillaria*.[1]

The ferns and other genera which I have described may be considered the types of the plants to which we are indebted for our stores of mineral fuel. They grew in extensive level plains, their fleshy roots penetrating the soft mud which formed the surface soil, or the spongy layer of vegetable matter which covered it. The moist atmosphere (not at all likely to have been charged with more carbonic acid gas than that of our own day) would encourage the growth of cellular parasites and epiphytes, and the Aroid discovered by Dr. Paterson, with the several species of Antholithes, most probably represent races of epiphytes of a much higher organization than the cryptogamic trees on which they flourished.

Coniferous trees may have grown on the margins of the plain, but their proper habitat seems to have been the higher ground, from which an occasional stem was floated down by running water to the plains below. What plants were associated with the Conifers in those upland regions, is as yet quite unknown. The Flora of the coal period as at present ascertained is that of the plains. And this is of high interest, apart from the economic value of its products, because it reveals to the biologist an assemblage of plants agreeing in all essentials with some of the humble members of our present Flora, but attaining at so early a period in the history of the world a development not only in size but in organization, greatly in advance of their modern allies.

II.—NOTES ON CONTINENTAL GEOLOGY AND PALÆONTOLOGY.

By THOMAS DAVIDSON, F.R.S., F.G.S.

(*Continued from p.* 263).

(PART IV.)

IN the June Number (p. 251), we gave Messrs. Pictet and Lory's most recent views on the disputed age of those beds which contain the *Terebratula diphya* or *T. viator* of Pictet. In order to complete their views I now publish a letter recently received from M. Hébert, which he requests me to add to the present notes.

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[1] For a lengthened examination of the affinities and structure of this genus, see a Memoir read to the Geological Society, at its meeting on March 24th, and to be published in its Quarterly Journal on the 1st of August next.

"Paris, *20th May* 1869.

M. Pictet, who maintains the utmost courtesy in our discussions, communicated to me some time ago an extract of the opinion he sent you regarding the *limestone with Ter. diphya*. It seems necessary in my turn to address you for the sole purpose of stating my opinion precisely. It shall be a short one, repeating very nearly what you will find in the Bulletin of the meeting of the 9th Nov., 1868, p. 138, and which will be speedily forwarded to you. If you read what I have published upon this question you will observe that I have hitherto only drawn up conclusions concerning the *limestones with Ter. diphya* or *janitor* of the Porte-de-France and those of Aizy which contain the same fauna. This fauna, composed in a great measure of *Cephalopoda*, is, to my mind, *certainly Neocomian*. The more I study the question the fewer are the doubts I have on this subject, because I find a greater number of species really Neocomian. But in the limestones with *Cephalopoda* there is intercalated at Aizy a thin bed of small extent, disappearing at a little distance, containing a mixture of this fauna with another which resembles the Coralline fauna. In like manner at Stramberg to the fauna with Neocomian *Cephalopoda*, of the Porte-de-France, is made the addition of *Diceras*, of *Brachipoda* and of *Nerinæa*, which had until now seemed identical with Coralline species. This portion of the fauna of Stramberg does not exist at the Porte-de-France, but is found identically the same at Inwald (Galicia), at Salève, at Echaillon, in the lower Alps, and in the Gard; but in all these localities of the Carpathians, of Switzerland, of the Dauphiné, and of Provence, this Coralline fauna has hitherto included none of the Neocomian *Cephalopoda* of the Porte-de-France, or of Stramberg; this remark ought not to be lost sight of by Geologists.

It is true that a more attentive examination has singularly reduced the number of identities admitted between this Coralline fauna and the veritable *Coral Rag* of the north and of the Jura; but we must not forget that the reputed Jurassic species are not found either at Aizy, or at Stramberg, save in those beds that are true breccias resulting from the destruction of an older deposit. Therefore the question concerning the limestone with *Cephalopoda* appears to me as much settled, as the question regarding the beds with *Diceras* and *Nerinæa* seem to me to be obscure. In fact, we do not yet know very positively if there is a single form identical with the Jurassic species. In the case of some identities still maintained we do not know whether they are contemporaneous with the deposit, or are species which have been introduced from a lower bed. We have now to study this curious fauna of Inwald, of Echaillon, of Salève, of the Serane (Gard). The most complete collections from these formations have been generously placed at my disposal by Messrs. Zejszner, Lory, Pillet, Wallet, and Jeanjean. Shall I have leisure and capability to derive therefrom a corresponding advantage? That is the question.

Anyhow it is certain that from the Carpathians to Montpellier the beds with *Terebratula Moravica* (Glock) constitute a stage distinct from the limestone with *Tereb. diphya*, or *janitor*, that we shall probably be able to observe in the south of France the stratigraphical relation of the two systems, and from notes recently sent to the Geological Society by M. Coquand, I can almost deduce that *Tereb. Moravica* is regularly inferior to *Tereb. janitor*. This, however, is not asserted decidedly as yet.

Pray inform your English colleagues that I have proceeded with the greatest caution, and that I have confined my observations to the beds with *Tereb. diphya*. These are the ones I have considered to be Neocomian. I have brought forward nothing in regard to the position of the formation with *Tereb. Moravica*. I am doubtful of the latter belonging to the Coralline period, but I know nothing of it. This to me is the actual horn of the problem. Oppel had referred to the Titonic formation, the Portland limestone, the beds of Boulogne, of Solenhofen, Nattheim, etc. Zittel, on the contrary, rejects with good reason all these from the Titonic stage, and I think we must also eliminate the limestone with *Tereb. diphya* as Titonic; there consequently only remains the limestone with *Tereb. Moravica*, which really appears to me very curious; but I cannot as yet pronounce upon its age decisively. These explanations will show you that M. Pictet and I are very close upon a mutual understanding, since the objections of my eminent colleague and friend rest now almost entirely upon the fauna of the bed containing *Tereb. Moravica*, and that I consider it in no way demonstrated that the fossils of these beds are contemporaneous with those containing *Tereb. janitor*."

In a letter recently received from M. Coquand, that gentleman states:—

> "I quite understand the difference in opinion which geologists entertain relative to the divisions of the Chalk, or Cretaceous system, but I cannot conceive why they should refuse to see what really exists. How is it? because, in France, we do not possess the Hastings sands or the Tilgate beds, should we deny their existence in England? Such would be neither logical nor philosophical. With reference to my Cretaceous stages, is it not true that the sands of Rouen (my "*Carentonien*") are situated above the beds with *Pecten asper?* If geologists should call the first "Upper Cénomanien," and the second "Lower Cénomanien," they would correspond to my divisions; no other change would be effected but the rejection of my names. It would be possible (likewise from the same motive) to efface the terms "Bradford Clay," "Cornbrash," "Fuller's Earth," etc., and to say instead Lower, Middle, and Upper Great Oolite. Is it, or is it not true, that above the bed with *Inoceramus labiatus* (Inferior Lower Chalk), and under the Upper Chalk with *Belemnitella mucronata* we possess in Provence—1st, thick beds with *Radiolites lumbricalis* and *Radiolites cornu-pastoris*; 2nd, 300 mêtres of sandstone (Grês d'Uchaux); 3rd, 150 mêtres of limestone with three forms of *Hippurites*, which are wanting both in England and Paris. Since such is the case, we cannot help admitting it; and if all this assemblage does occur in the South of France, it must result, that in a general classification of the system one cannot suppress these beds. I am aware that I shall be answered that the Turonien or the Craie Marneuse would correspond to the above-named assemblage of beds; but as this assemblage lies in Provence above the bed with *Inoceramus labiatus* and under that with *Micraster cor-anguinum*, the result is that the complete series of the Chalk does not exist at Paris nor in the North of France, but must be seen in the South of France. Had the English or Parisian geologists possessed this stage in their country, they would scarcely have failed to introduce it into their series or classification, and they would have been right in so doing. It is just as if one denied the existence of the Muschelkalk because it is absent in the British Isles. In a science of observation, one must progress by the aid of positive facts. I defy any geologist to explain the sections in Provence by the Chalk series as found in England and in the North of France. It is just as if English geologists had the pretension to include in the Speeton Clay all the Lower Cretaceous divisions of the Continent. What Mr. Judd has demonstrated is this, that you possess equivalents of some. Each district has its peculiar and local formation, and it is there that one should seek for the type."

I believe Geologists will concur with M. Coquand that the complete sequence of geological formations cannot be found or sought for in any particular or limited district, and that in all sound general classifications one must take into consideration those deposits which may be present in different parts of the globe, and, as far as such a thing is possible, locate them into their proper stratigraphical position. We must, however, carefully avoid too minutely dividing and subdividing our great divisions, for by exaggerating the number of our stages we might, perhaps, be liable to fall into the prevalent mistake among Palæontologists, namely, that of forming an unnecessary number of so-termed *distinct* species or varieties out of one great but variable specific type.

I quite agree with M. Coquand that neither in England nor in the north of France do we possess several of the étages he describes, and, no doubt, with time and further consideration, we shall arrive at a suitable general classification of the system, which will embrace all the divisions that occur in different countries. In the meantime further study of the system is urgently requisite, and many points now advanced will, prior to definite adoption, require to remain open questions.

In connection with the subject under discussion, Dr. M. Neumayr favours me with the following statement (Vienna, June 5) :—"Sir, Having read in the June number of the Geological Magazine two notes communicated to you by MM. Lory and Pictet, in reference to the classification of the beds with *Terebratula diphya*, wherein the close affinity of the limestone of the Porte-de-France with those of Stramberg, and with the Klippenkalk of the Carpathians are several times pointed out, I think it will not be uninteresting for you to record a few additional notes on the position of these beds which, in the Carpathians, constitute the Tithonic stage. I therefore send you a few lines relating to these formations, which I studied for nearly three months last year.

"There are in the Carpathians two parallel bands, each of them more than a hundred English miles in length, and in width rarely exceeding one mile, covered by a great number of ridges or reefs of Jurassic and Tithonic limestones, which pierce in discordant order the Neocomien marls. A great number of the reefs ('Klippen') in the northern band are composed of the Stramberg limestone, while that rock is very seldom found in the southern band, but, on the contrary, there is an abundance of the Klippenkalk (calcaire des récifs), a denomination which has not a very precise signification, and under which are united or combined various beds of very different age. Nevertheless I succeeded in finding the Stramberg limestone in two localities in this southern band, and in one of them the superposition of this bed on the most recent portion of the Klippenkalk (the breccia with *Ter. Catulloi* or *diphya*,) is very distinctly observed.

"The beds of the Klippenkalk, which are connected with the question at issue, consist here, at their base, of a red nodular limestone, containing a fauna corresponding pretty nearly to the one with *Ammonites tenuilobatus*, said to be Oxfordian by M. Lory, which is found at the bottom of the beds with *Ter. janitor* at the Porte-de France, and which should be placed according to another opinion in the Kimmeridgian stage. In the upper beds of the reddish limestone are found already intermingled with the fossils of the first horizon the *Ter. diphya* and several Ammonites by which this species is ordinarily accompanied. The next layer is rather thick, and consists of a breccia made up in some places of *Ammonites*, *Terebratulæ*, etc., in such excellent preservation and so different to what is found in all other neighbouring layers, that it is impossible to admit the likelihood of a mixture of fossils. I published in the fifth number of 'Verhandlungen der Geologischen Reichsanstalt,' Vienna, 1869, a list of the fossils which are found in the breccia, from which it is apparent that by the side of a great number of forms peculiar to the stage is found one Neocomian, and two or three Jurassic species; two forms of a Cretaceous type, eleven species of a Jurassic type; eight forms are common to the breccia and to the Stramberg limestone, which immediately overlies it at Kiow in Hungary, and on the frontiers of Poland.

"The fauna of Stramberg is now so well known that it is sufficient to mention that the Cephalopoda of this locality approach a little nearer to the Neocomien type, while the Echinoderms and the Brachiopoda have somewhat more of a Jurassic aspect; nevertheless their resemblance to the former or the latter fauna is very slight. Elsewhere the fauna of Stramberg is very intimately allied to that of the breccia of the Klippenkalk by a number of identical or analogous species; so much so, indeed, that these beds ought, in my opinion, to be united into a single stage, namely, the Tithonic, of which they represent two horizons. The Stramberg limestone corresponds exactly to the limestones with *Ter. janitor* of the Porte-de-Franco, the breccia of the Klippenkalk to the white limestone with *Tereb. diphya* of the centre of Italy, while the upper portion of the 'Ammonitico Rosso' of the Southern Tyrol represents those two horizons in a single bed.

Carpathians.	Southern Tyrol.	Central Italy.	Porte-de-France
Limestone of Stramberg	Upper portion of the "Ammonitico Rosso."		Limestone with *Ter. Janitor.*
Breccia of Klippenkalk.		White Limestone with *Tereb. diphya.*	Bed with large *Aptychus* ?

"In regard to the classification of the formations in question, MM. Lory and Pictet have adopted the opinion expounded by Oppel, who correlates them with the freshwater deposits of the north-west of Europe, on the limits of the Cretaceous and Jurassic formations. It, therefore, appears to me a question of secondary importance, and more or less formal, whether the beds in question are placed in the Jura or the Chalk, stating at the same time that the Tithonic beds in the districts I have been able to visit, namely, in the Southern Tyrol and Carpathians, are in closer connection with the Jurassic than with the Neocomien deposits. I only insist, however, on the re-union of these formations in a stage independent alike of the Kimmerigian and the Neocomien, for which Oppel proposed four years ago the name of *Tithonic stage.*"

Since the publication of the June number of the GEOLOGICAL MAGAZINE, Dr. U. Schloenbach, of the Imperial Museum of Vienna, has kindly transmitted to me the following table and remarks, with a request that they should be added to my Continental notes. "Allow me to address to you, on this occasion, a few remarks on the upper part of the Cretaceous formation (Pläner of Prof. Gümbel) in the countries where I have had the opportunity of studying it myself—namely, the ancient province of Maine in Western France, Northern France, Northwest Germany, Saxony, and Bohemia, and the Northern and Western Calcareous zones of the Eastern Alps in Austria. In the accompanying table (see p. 306) I have attempted to exhibit my views on the parallelism of the strata in those regions. In this table I have omitted our Austrian Alps, as my opinion on the different strata developed therein is not yet quite fixed; as for the Gosau beds representing this formation in the northern zone, they seem to include, in my opinion, all the strata indicated in the table upwards, from the zone of *Inoceramus Brongniarti*, and *Am. Woollgari*, and possibly the zone of *Inoceramus labiatus* also, while the Cénomanian stage does not seem to be represented at all. This view differs somewhat from any of those hitherto issued, principally from that of Prof. Zittel, who regards the Gosau formation as representing only the "Etage Provencien" of M. Coquand, but the Stratigraphical and Palæontological researches I shall publish by-and-bye, induce me to distinguish a series of strata lithologically and palæontologically different. In the southern zone of our Calcareous Alps in Tyrol and Venetia, the development of the Upper Cretaceous formation is more simple and uniform, principally so in the Western portions of this country, to which I have necessarily confined my researches. The so-called "Scaglia" there overlying the Neocomian limestone, called "Biancone," is the only representative of the Upper Cretaceous series in this region, while, farther eastward, it acquires a greater thickness and a more varied development by the intercalation of beds very rich in *Rudista*. The Scaglia of Southern Tyrol consists of alternating beds of Grey and Red Chalk-marl and Calcareous marl, containing but few fossils. Besides which, these fossils seem to be the same throughout the whole thickness of the series, so that it is scarcely possible to make any palæontological distinction within it. The fossils are generally in so bad a state of preservation, and the number of species as yet known is so small, that it is rather difficult to form, or obtain a precise opinion on the age of the Scaglia; yet the general character of its fauna, consisting of *Echinoidea*, *Rudista*, and *Inocerami*, bears a close resemblance to that of the "Oberer Pläner" in North-western Germany, *i.e.*, with the zones of *Inoceramus labiatus*, *Inoc. Brongniarti*, *Micraster breviporus*, and *Micraster cor-testudinarium*.

"I must add some further remarks on the accompanying table. The first column contains a general classification in which all the strata developed in the different regions indicated in the following columns may easily be arranged. The second and third columns are intended to give an idea of my views concerning the parallelism of the principal divisions made by M. Triger in the Department de la Sarthe, with the general classification, and also with that of M. Hébert for the Paris Basin. You will find that in this I agree in most points with M. Hébert, and it would be too long to point out and discuss here the slight differences existing between our views. As for the fourth column, the series there enumerated, and their relative horizon as compared with those of the foregoing column, have been discussed in several publications.[1] For the

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[1] Ueber die Parallelen zu d. Oberer Pläner Norddeutschlands und den Gleichalserigen Bildungen im Seine-Becken (Neues Jahrb. für Min. 1866, p. 309). Krit Studien über Kreide Brachiopoden (Palæontographica, xiii. 6). Ueber die Brachiopoden Norddeutscher Cénomanbildungen (Geogn. Pal. Beiträge, i. 3). Ueber die Galeriten Schichten der Nordd. Kreide (Sitzber. Akad. d. Wiss., Wien, lvii. 1).

TABLE OF THE UPPER CRETACEOUS STRATA (PLÄNER OF M. GUMBEL), prepared by DR. U. SCHLOENBACH.

PLÄNER OF M. GUMBEL

I.	II. WESTERN FRANCE (MAINE). Classif. of M. Triger.	III. NORTHERN FRANCE Classif. of M. Hébert.	IV. NORTH-WEST GERMANY.	V. SAXONY AND BOHEMIA.
Zone of *Bel. mucronatus.*	Wanting.	Pisolitic Limestone. Marl with *Baculites.* Zone with *Bel. mucron.* (of Meudon).	Maestricht-beds, Fish-beds of Sendenhorst and Baumberge, in Westphalia. Marl with *Bel. mucronatus* and *Helicoceras* from Haldem and Ahlten (Hanover). Chalk with *Bel. mucronatus* and many Brachiopoda, at Schwiecheldt, Ahlten and Lüneburg (Hanover).	
Zone of *Bel. quadratus.*	Wanting.	Zone with *Bel. quadratus,* at Rheims and Sens (Yonne).	Marl with *Bel. quadratus* and *Offaster corculum,* at Coesfeld (Westph.), Ahlten and Schwiecheldt (Hanover), and at Biewende, near Wolfenbuttel (Brunsw.).	Wanting.
Zone of *Bel. Merceyi* and *Micraster cor-anguinum.*	Wanting (?)	Zone with *Micr. cor-anguinum,* at Dieppe and Amiens.	Sandstone and sands of Vaels and Aix-la-Chapelle, of Haltern (Westph.); Chalk with *Bel. Merceyi* and *Micr. cor-anguinum* of Lüneburg (Hanover); Tuffean Marl of Gehrden, Bülten and Goslar (Hanover); Marly Sandstone of Quedlinburg and Blankenburg, in the Hartz.	Upper Quader of Kreibitz, Daubitz, Böhmisch Leipa, Chlomek, near Tungbunzlau (Bohemia).
Zone of *Micr. cor testudinarium* & *Inoc. Cuvieri.*	(?) Zone of *Spondylus spinosus.*	Zone of *Micraster cor testudinarium,* at Fécamp, Armeau (Yonne) etc.	Plaener (Marl), with *Inoceramus Cuvieri* and *Micraster cor-testudinarium,* of Steinlake, Salzgitter and Goslar in the Hartz (Hanover).	Marl and clay with Baculites, *Inoceramus Cuvieri,* and *Micr. cor-testudinarium,* at Priesen, Luschitz, Sowitz, near Raudnitz, Böhm. Leipa, Dneboch, near Münchengrätz and around Königgrätz and Pardubitz, in Bohemia.
Zone of *Micr. breviporus, Scaphites Geinitzi* and *Spondylus spinosus.*	Zone of *Spondylus truncatus* or "Craie de Villedien," with *Ostrea auricularis* and *Spondylus truncatus.*	Zone of *Amm. Prosperanus,* at Châlons, Armeau, Cap Blanz-Nez.	Plaener (Chalk marl), with *Spondylus spinosus, Scaphites Geinitzi* and *Micraster breviporus,* at Neuenbeken (Westph.), Heiningen, Salzgitter, Goslar (Hanover), Neinstedt and Ruedlinburg in the Hartz; Greensand of Aplerbeck and Rothenfelde (Westphalia).	Marly limestone (Oberer Planerkalk), with *Scaphites Geinitzi, Spondylus spinosus, Terebratulina rigida,* etc. at Strehlen, near Dresden (Saxony), Teplitz, Kostitz, Chrudim, and clay with *Ostrea sulcata,* at Hoschkowitz and Pedol, near Münchengrätz (Bohemia).

Pläner of M. Gümbel	Zone of *Inoceramus Brongniarti* and *Amm. Woollgari.*	Zone of *Ammonites peramplus.*	Zone of *Inoc. labiatus.* Upper part rich in *Rhynch. Cuvieri*, at Fécamp, Cap Blanc-Nez.	White Planer (Chalk marl), with *Inoceramus Brongniarti*, *Holaster planus*, and *Amm. Woollgari*, at Wolfenbüttel, Salzgitter, Goslar (Hanover), Büren (Westph.), with *Galerites*, at Ahaus (Westph.), Salzgitter, and Vienenburg (Hanover).	Quader of Saxon Switzerland, Greensand of Kopitz, near Pirna (Saxony); Quader of the Schneeberg Bohemia, Marly Sandstones (Iser-Schichten) valley of the Iser (Bohemia), Callianassa Sandstone of Eastern Bohemia, Greensand and "Exogyren-Sandstein," of Laun (Bohemia), Upper "Pläner-Sandstein," of West Bohemia.
	Zone of *Inoceramus labiatus.*	Zone of *Rhynchonella Cuvieri.*	Lower part, rich in *Inoc. labiatus*, in the same localities.	Red Planer-limestone with *Inoceramus labiatus*, at Altenbeken and Stupelage, near Bielefeld (Westph.), at Sarstedt, Salzgitter, Liebenburg, Vienenburg (Hanover); grey marl in west Westphalia.	Quader of Cotta and Rottwernsdorf, near Pirna, and of Schandau in the Saxon Switzerland, Quader with the *Inoc. labiatus* at Tyssa (Bohemia), Lower "Pläner-Sandstein" of West Bohemia.
	Zone of *Amm. navicularis.*	Zones of *Ter. Carantonensis.* *Ostr. biauriculata.* *Rhynchonella compressa.*	?	? ? ?	? ? ?
	Zone of *Amm. Rothomagensis Scaphites aequalis Amm. varians* and *Mantelli.*	Zone of *Turrilites costatus.* Zone of *Pygurus lampas.*	Zones with *Holaster subglobosus*, and with *Hol. carinatus.*	Grey Planer-Marl with *Amm. Rothomagensis* and *Hol. subglobasus*, at Altenbeken (Westph.), Rethen, Burgborf, near Schladen, Salzgitter (Hanover), Langelsheim (Brunswick). Grey Planer with *Amm. varians* and *Mantelli*, *Scaphites aequalis*, *Turrilites*, *Holaster carinatus*, etc., at Burgdorf, Salzgitter (Hanover), Langelsheim, and Broitzen (Brunsw.), ? Greensand of Quedlinburg (Hartz).	? Lower Planer of Plauen and Lower Quader of Koschütz, near Dresden; Greensand of Klein Herrendorf, near Prague; of Smrcek, near Chrudim (Bohemia; Fossiliferous Sandstone of Tyssa and Zlosein (Bohemia); Conglomerates and Limestones, with *Rudistae* of Korytan and Radowesnitz, Lobkowitz; fossilliferous marls of Kolin, Kuttenberg, etc. (in Bohemia).
	Zone of *Catopygus carinatus.*	Zone of *Turrilites tuberculatus.*		Greensand with *Am. Mantelli*, *varians*, *Holaster carinatus*, *Catopygus carinatus*, *Pecten asper*, Essen (Westph.), *Bel. ultimus*, at Salzgitter and Langelsheim.	? Conglomerates without fossils; Sandstone and marl with freshwater shells and plants, at Niederschöna (Saxony), Perutz, Tinonitz, Kounitz, (Bohemia).
		? Zone of *Ostr. vesiculosa.*	Zone with *Hol. suborbicularis.*		
Gault	Zone of *Amm. inflatus, splendens.*	Wanting.	Gault with *Am. inflatus, splendens*, Wissant, etc.	Flammenmergel with *Amm. inflatus* and *splendens*, *Aucella gryphaeoïdes.*	Wanting.

fifth column I refer to my paper, "Über die Brachiopoden der Böhmischen Kreide" (Jahrb. d. k. k. Geol. Reichsanstalt, 1863, xviii. 1), and to my reports published during the summer of 1868, in the "Verhandlungen d. k. k. Geol. Reichsanstalt, where I have explained in detail my views on the Cretaceous formation in Saxony and Bohemia."

2.—*Notes on the Geology and Palæontology of the Neighbourhood of Nice.*

Nice, and its surrounding mountains, offer to the Geological as well as to the Palæontological inquirer, subjects of considerable interest, I have, therefore, availed myself of a winter's residence in the South of France to study some of their most important features. I soon learned that the fashionable and much frequented town of Nice,[1] possessed but two or three local Geologists, and indeed I found that M. Ph. Gény, Inspector of the public promenades of the town, was the only individual who devoted his serious attention to the subject upon which I am writing. M. Gény, who from his varied acquirements in Natural History, Geology, Palæontology, Botany, and Archæology, has been locally styled the "Buffon of Nice," alone possesses in the town a really scientifically classed and nearly complete local collection, which he shows with the utmost courtesy to all those who desire to become acquainted with the products of the district. Besides conducting me to the most important localities, he afforded me much of the information I propose to give here.

To the Chevalier Perez I am likewise indebted for much politeness and information. He had, in former years, paid considerable attention to the geology of the district, with which he is well acquainted. Having been desirous of leaving Nice at the period of the annexation to France, he liberally presented his geological collection to the small but interesting museum[2] of the town. Somewhat prior to the labours of the two gentlemen above named, the district had in a measure been explored by the well-known chemist of the town, Antonio Risso, and the result of his labours (now much out of date) were published in his work "Histoire Naturelle de l'Europe Méridionale," and at the Villa Risso may be seen many interesting local fossils, assembled by the last-named naturalist. When we have stated that M. Cameré, one of the engineers of the town, occasionally collects fossils, we shall have enumerated the geological resources of the place; for although there exists a large public library, scientific works are the greatest rarities therein, and without books of reference no work can be satisfactorily achieved now-a-days.

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[1] Doctors sometimes most injudiciously send their exhausted patients to Nice, without considering whether they can stand the diurnal variations in temperature, discomforts, cost, and very indifferent food.

[2] This museum was founded by A. J. B. Vérany, a distinguished naturalist. It contains, among other things, a good collection of recent shells, and a remarkable series of models of all the mushrooms found in the Department of the Maritime Alps. These have been made at a considerable cost by M. Brala, the present Director of the Museum. There exists also a good collection of Butterflies, presented by M. *Haas*, a zealous local Naturalist.

Although the district surrounding Nice is replete with subjects of considerable interest, I am sorry to say that there does not appear to be any satisfactory map, or any complete work on the Geology and Palæontology of the Department. In several general Geological maps the district has been vaguely included; thus we may name those of Pareto, Sismonda, De la Beche, etc., but these are mere sketches, and upon by far too small a scale for useful purposes; indeed, it would require much time, labour and expense to map out correctly so disturbed and mountainous a region as the one under notice. The attempt has been made by M. Gény, but his map has not been hitherto published.

Many geologists have in succession visited the neighbourhood of Nice, and perhaps the best memoirs or sketches upon the subject are those by Sir H. T. de la Beche and Dr. Buckland, published in the Transactions of the Geological Society of London (vol. iii. 2nd ser., 1829); a paper, by Faujas St. Fond, in the tenth volume of the Annales du Musée; one by Allen in the seventh volume of the Tranactions of the Royal Society of Edinburgh; and another by Sir R. Murchison; a memoir "On the limits of the Cretaceous formation in the Maritime Alps" by Perez (Atti della ottava reunione degli Scienziati Italiani, 1847); Bellardi's excellent monograph of the Lower Tertiary Fauna of Pallarea, near Nice; and several articles contributed by M. Gény to the volume of the Congrès Scientifique of France at Nice in 1867, are, I believe, among the principal fragmentary records which may be consulted on the geology of the district.

The chief object of my own examination of a small portion thereof was to acquire a superficial knowledge of its general geology, and to study in particular those Tertiary, Cretaceous, and Jurassic formations containing Brachiopoda; but prior to detailing my personal observations, I will lay before the reader an unpublished section given to me by M. Gény during my residence in Nice, in which will be found in a condensed shape the results of the many years he has devoted to the exploration of the department in which the town of Nice is situated.

General Summary of a Geological Section of the Department of the Maritime Alps, by M. Ph. Gény. 1869.

In the department of the Maritime Alps there are representatives of the larger number of known geological formations. We distinguish first of all several systems of upheaved mountains, accompanied by subsidences, depressions, and enormous faults, then the central points of our Alps (forming the granitic nucleus of our Alpine system) attains an altitude of 3118 metres above the level of the sea. The culminating point, termed Mount Gélas, has its principal axis from north-west to north-east, from which converge a multitude of minor ranges, of which the longest stretches to the south and towards the sea (those of the north constituting a portion of Piedmont), naturally dipping in an opposite direction to that of the principal axis; consequently we see nearly all the lower formations in succession tilted up and set back to back almost continuously against the central axis, but generally in a more or less metamorphic condition at, or near, their point of contact with the unstratified or igneous mass.

The quartzose derivatives which border the granito-gneissic crystalline nucleus, are sienites, eurites, porphyries, serpentines, schists, etc; the Greywacke and Saliferous schists lie close to these first derivatives. The Carboniferous formation follows a parallel direction to that of the great axis of upheaval of the centre of the basin of the Maritime Alps, and forms a band in the shape of a bird's tongue, which, extending from north-east to south-west, denotes the continuity of this formation by Draguignan to the Esterel. This band is margined by different stages both of the lower and middle Jurassic series. Now, as the metamorphic action has affected all the rocks in its immediate contiguity, we find the Liassic stages have, in part, been converted into marble, while the Oolitic, Oxfordian, Coralline, and Portlandian stages are often transformed into Sulphate of lime, forming at the same time minor centres of chemical action, of which the neighbouring parts are frequently converted into Dolomite, and where the magnesian influence has often reduced them into a coarse sand, causing frequent doubt to arise in reference to their age: added to all this, their poverty in fossils deprives us of that which might otherwise have afforded a means of identification.

The Cretaceous strata attain a thickness nearly equal to that of the Jurassic, and being in close approximation to the posterior portion of the centre of our Alpine basin, have in turn undergone enormous convulsions,—as may be perceived from the almost vertical inclination of the beds and their numerous flexures. These contortions and contractions are accompanied by numerous faults, fractures, and overthrows in the stratification; thus causing, at times, considerable uncertainty as to the age of the deposits, or where the line of contact with the lower or upper one commences or terminates. Some of the stages are rich in organic remains.

The Tertiary deposits, which spread over nearly the whole of our Alpine crests, terminate the Department at its four angles, and the extremities of these outliers are lost beneath the Mediterranean. Others do not extend higher than the middle of the Alpine basin, and the average thickness of the strata nearly equals that of the larger number of the Cretaceous ones. The rocks of this period in the district surrounding Nice have undergone no modification by the action of former chemical influences, but in other portions of the Department certain changes have taken place. The lower and upper Tertiary strata are very rich in fossils, though very much out of shape (see the much esteemed works of Messrs. Deshayes, E. Sismonda, and L. Bellardi, of which the detailed catalogue of the Nummulitic fossils from the ancient county of Nice is sufficiently *recent, 1853).*

The upper stages are very rich in Gasteropoda and Rhizopoda, but in the neighbourhood of Nice they are rarely found lying conformably on the lower beds, but are more often seen resting unconformably on the Cretaceous and Jurassic strata that lie beneath.

The stages or deposits referable to the present period (Quaternary) generally repose on Lower Tertiary deposits, as well as upon the most ancient of those belonging to the Upper Jurassic period. I have likewise been able to notice in some of these deposits along our shores, that deep sea beds have been frequently thrown up, together with the mollusca they contained, the thickness of their shells much exceeding that of the same species inhabiting the Mediterranean at the present day.

SECTION.

I. CONTEMPORANEOUS PERIOD (QUATERNARY).

a. ACTUAL OR RECENT; alluvium and concretions. *Upper bed*: land increased by sea shore, fluviatile and marine deposits, limestones, marls, etc.; horizontal; thickness, five metres; discordance with the Tertiary, Cretaceous, and Jurassic formations. Heterogeneous composition. Recent fauna and flora. In many places Glacial drift; Breccias. Lower bed: arenaceous and pebbly deposits. Inclin. 15 deg. N.S.; two metres; discordance with the Coralline Limestones: heterogeneous deposit, fragments of undeterminable shells. Loc. Mt. Boron, St. Philippe, St. Hospice, near Nice.

b. ANTROPO-LITHOSIEN, Gény—Stone age. *Upper bed*: deposit of Osseous breccia in caves. Inc. 17 deg. N.S.; one metre fifty centimetres in thickness; discordance with the dolomites. Heterogeneous composition. *a.* with cut flints; *b.* with polished flints and serpentine. Loc. Antibes, Castle of Nice, Menton, etc.

— Marine diluvian; lower bed, deposit of white marls with sub-fossils, situated at from three to five metres above the level of the sea. Inc. 20 deg. N.E.; thick. 70 centimetres. Discordance with the deposits of Parisian marl; bed composed of agglutinations of fragments of shells, white limestones and siliceous sands. Recent fauna, deep sea fauna. Loc. Beaulieu and Monaco.

II. TERTIARY PERIOD.

a. SUBAPENNINE or Older Pliocene (Lyell). *Upper bed* sandy and pebbly; conglomerate, etc. Inc. from 20 to 30 deg. N.W.; 60 metres. Discordance with the Tertiary, Cretaceous, and Jurassic. Contains several rolled and transported fossils—*Turritella communis*, *Natica glaucina*, etc. Loc. Hills of Bellet, Magnan.

— *Median bed*—Sands and yellowish plastic clays, etc. Inc. 20 to 30 deg. N.W.; 10 metres. Discordance as above; tolerably rich in Gasteropoda and Bryozoa. *Bulla spirata*, *Vermetus articulatus*, D'Orb. Loc. St. Jean, St. Etienne, Trinité, Nice.

— *Lower bed*—Bluish plastic marls, etc. Inc. 20 to 30 N.W.; 30 metres. Discordance as above. Less rich in Gasteropoda and Bryozoa. *Buccinum maculosum*, D'Orb. Loc. Mantega and Fontaine du Temple, near Nice.

b. FALUNIEN, D'Orb. (Molasse), Upper Miocene (Lyell); ferruginous arenaceous marls, etc. Inc. 25 to 35 deg. E.; 15 metres. Discordance with the Lower Tertiaries; poor in fossils. *Rhyno. bipartita*, *Ter. pedemontana*. Loc. Baumettes and Lazaret, Nice.

— *Lower bed*—Ferruginous, tuffaceous marls, etc. Inc. as above; 50 metres. Discordance as above; few fossils; undeterminable Zoophytes. Loc. Fossan, Bordighèra, etc.

c. TONGRIEN, D'Orb. Lower Miocene (Lyell). *Upper bed*, bay coloured sandstones and grits, etc. Inc. 30 to 40 deg. E.; 20 metres. Discordance as above; poor in Gasteropoda, but rich in Foraminifera. *Clypeaster truncata*, *Agas. scutella*. Loc. Calvaire, à Vence, Fossan at Menton.

TERTIARY PERIOD—*continued.*

— *Lower bed*—Fine blackish grey anthracitic sandstones, etc. Inc. 30 to 40 deg. E. Discordance as above. Some branched Zoophytes, undeterminable. Loc. Garavent, east of Menton.

d. SUÈSSONIEN, D'Orb. Plastic Clay (Mantell) upper bed. Plastic Parisian Marls or London Clay. Inc. 40 to 50 deg. E. Discordance with Cretaceous; not rich in fossils. *Rhizopodes, Goniaster, Orbitoides radians,* D'Arch. Loc. Villeneuve and Villafranche, near Nice.

— *Middle bed*—Arenaceous sandstone (Mantell); earthy Parisian limestone, crumbling when exposed to the air, etc. Inc. from 40 to 50 deg. E.; 7 metres thick. Discordance as above; tolerably rich in fossils. *Turritella imbricata,* Lamk. *Natica patula.* Loc. Cagnes, Pallarée, Menton.

— *Lower bed*—Eocene (Lyell). Hydraulic limestone. Inc. 45 to 55 deg. S.E.; 15 metres thick. Discordance with the Cretaceous and Jurassic. Very rich in fossils. Gasteropoda. *Nautilus regalis, Fusus Noe, Ostrea flabellula.* Loc. Beaulieu, Jarrier, Braus, Mortola.

III. CRETACEOUS PERIOD.

Epoch. B. DANIEN Desor wanting.

SÉNONIEN, D'Orb. Argillaceous limestone. *Upper bed*—White marls and grey limestone, friable when exposed to the atmosphere. Inc. 50 to 60 deg. N.E.; 150 metres. Discordance with the Jurassic (throughout the whole Cretaceous period); poor in fossils. *Nautilus simplex,* Sow. *Scaphites compressus.* Loc. Mt. Gros, Mt. Maccaron, St. Cécile.

— *Lower bed*—Compact marly limestone, of a greyish colour, crumbling on exposure. Inclination and thickness as above; poor in fossils. *Micraster cor-anguinum, Ananchytes ovata.* Loc. Mt. Gros, Mt. Rinardière Cantaron.

TURONIEN, D'Orb. Lower Chalk-marl (Sow.) *Upper bed*—Greyish marly limestone (Tuffau) with few siliceous grains. Inc. 60 to 70 deg. N.E.; 70 metres thick; not rich in fossils. *Ammonites peramplus, A. Woolgari.* Loc. Mt. Papaton, Mt. St. Catherine at Drap.

— *Lower bed*—Marls with numerous siliceous grains, either compact or friable. Inc. 60 to 70 deg. N.E.; 230 metres thick; few fossils. *Am. deverianus. Janira quadri-costata.* Loc. Mt. Gros, l'Abbadie, Ese, Drap, etc.

CÉNOMANIEN, D'Orb. Chalk-marl (Mantell). *Upper bed*—Grey bay coloured plastic clay, with a small quantity of alumina, etc. Inc. 70 to 80 deg. N.E.; 2 metres thick; poor in fossils. *Nautilus elegans, Am. Rhothomagensis.* Loc. Mt. Gros, Col de Papaton, etc.

— *Median bed*—Lead grey, compact schists with cleavage lines, breaking up into small parallelepedes. Inc. 70 to 80 N.E.; 10 metres; fossils few. *Am. varians, A. falcatus, Scaphites æqualis.* Loc. Varnée, Vienne, Blausasque.

— *Lower bed*—Whitish, compact marly limestone, veined with white spar. Inc. from 80 to 90 deg. N.E.; 100 metres thick; here Ammonites attain their largest dimensions. Turrilites and Inoceramus. *Discoidea cylindrica, D. tubuculus.* Loc. Mt. Gros, Drap, Mt. Rinardière.

ALBIEN, D'Orb. PERIOD A. Gault. *Upper bed*—Green siliceous marls (Glauconite), very friable. Inc. from 80 to 90 deg. N.W.; 30 centimetres thick; very rich in fossils. *Ceratites Seneguieri, Am. deluci.* Loc. Ese, Rayet, Papaton, etc.

— *Lower bed*—Compact grey marly limestones with green siliceous grains of iron (Glauconite). Inc. 40 to 50 deg. N.W.; 80 centimetres thick; rich in fossils. *Amm. mammillatus, A. cristatus, Turr. catenatus.* Loc. Laghet, Papaton, Ese, Rayet.

APTIEN, D'Orb. Speeton Clay (Phillips). *Upper bed*—Greenish grey siliceous friable marls, containing very little lime. Inc. 45 to 55 deg. N.W.; 10 cent. in thickness; not very rich in fossils. Fucoids. *Belemnites semi-canaliculatus, Am. Matheroni.* Loc. Saurée, Mt. Gros, Turbie, etc.

Lower bed—Compact, green, and blackish siliceous marly limestone. Inc. as above; 40 centimetres in thickness; poor in fossils. *Am. Guettardi, Toxaster complanatus.* Loc. St. Blaise, Revel, Baus.

Cretaceous Period—*continued.*

Urgonien, D'Orb. Speeton Clay, Judd (Pars). Lower Green Sand (Fitton). *Upper bed*—Marly limestones (Glauconie), not very siliceous, and breaking up by exposure to air. Inc. from 45 to 55 deg. N.W.; 90 cent. thick. Fauna rich here and there, but the fossils generally attaining small dimensions. *Belemnites*, *Ammonites*, *Gasteropoda*, *Brachiopoda*, etc. Loc. Drap, Saurée, Ese, Mt. Chauve, etc.

— *Lower bed*—Compact spathose marly limestones, with green siliceous grains. Inc. as above; rich in deep sea fossils of large dimensions. *Ancyloceras*, *Hamites*. *Nautilus varulensis*, etc. Loc. Revel, Ese, Rap, Rayet, etc.

Neocomien, Thurm. *Upper bed*—Lead grey, marly limestone, neither siliceous nor oolitic. Inc. 50 to 60 deg. N.W.; 60 cent.; very rich in fossils, but often confounded with those from the Cénomanian Stage of Nice on account of their colour. *Hamulina Emerici*, D'Orb. *Tereb. diphyoides*. District near Grasse, Mount Cheiron.

Lower bed—Bay coloured marly limestone, with ferruginous oolitic structure (Fauvonie). Inc. as above; 70 cent. thick. Very rich in fine fossils, but always found in depressions or faults. *Nautilus Neocomiensis*, *Am. Neocomiensis*. Loc. Mount Chauve, Mount Leuse, Drap, Turbie.

Wealden. Weald Clay wanting.

IV. Jurassic Period.

Portlandien, D'Orb. Portland stone and sand. *Upper bed*—Earthy grey compact limestone. Inc. 70 to 80 deg. N.; 150 metres thick. Few fossils. *Nerinea terebra*, Ziet. *Pentacrinus*. Loc. Sarratan, Drap, Turbie.

Kimmeridgien, D'Orb. Kimmeridge Clay, Fitton, wanting.

Corallien, Thurm. Coral-rag (Phil.). *Upper bed*—Milky white limestone, with fine grains (strong lime). Inc. 65 to 85 deg. N.; 20 metres thick. Rich in Zoophytes (corals). *Diceras arietina*, *D. Mosæ*, etc. Loc. Mount Chauve, Lazaret of Nice, Cap Martin.

Middle bed— Grey, sulphated, amorphous, masses, red and black in colour. *Cidaris coronata*, Goldf. *Ostrea gregaria*, Sow. Loc. Cimies, near Nice, Col of Villefranche, etc.

Lower bed—Dolomitic mass, white, grey, red in colour, saccaroid. *Acrocidaris tuberosa*, Ag.; *Astarte elegans*. Loc. Mount Vinaigrie, St. Pons, Baus-Rous.

Oxfordien, D'Orb. Oxford Clay (Phil.). *Upper bed*—Compact and nodular, marly limestones. Inc. 70 to 90 deg. N.; 50 metres thick. Tolerably rich in Ammonites, *Amm. tortisulcatus*, *A. tatricus*, *A. perarmatus*. Loc. Caire of Mount Causimagne.

— *Middle bed*—Compact limestone, with siliceous nodules. Inc. 70 to 90 deg. N.; 80 metres thick; poor in fossils. Loc. Valley of St. André, Mount Leuse, near Nice.

— *Lower bed*—Metamorphic limestone, Gypsum and dolomite. Loc. Mount Ferrillon, Mount Agel, etc.

Callovien, D'Orb. = Kelloway-rock (Phil.). *Upper bed*—Compact limestone, without Oolites. Inc. from 75 to 95 deg. N. *Amm. athleta*, Sow. Loc. Valley of St. André, near Nice.

— *Lower bed*—Compact, slightly Oolitic limestone. Inc. as above; 1 metre. 50 cent. thick. Loc. Caire of Mount Chauve, near Nice.

Bathonien, D'Omalius, Great Oolite (Phil.) *Upper bed*—Compact limestone, large oolitic grains, etc. Inc. 75 to 95 deg. N.; 20 metres thick; poor in fossils. Loc. Grasse, La Marbrière.

Bajocien, D'Orb. Grey Limestone (Phil.) *Upper bed*—Ferruginous Oolitic limestone, etc. Inc. as above. Loc. Mouans-Sartoux, Tignet, Mongins.

Toarcien, D'Orb. Upper Lias Shale 'part, Phil.) *Upper bed*—Calcareous marls, crumbling by exposure to the atmosphere, etc. Inc. 70 to 80 deg. N.; 8 metres thick. *Amm. Bolandrei*, D'Orb. Loc. Col de Monale, St. Dalmas le plan.

— *Lower bed*—Blue limestone, Dolomite or Gypsum; rock well crystallized. *Am. annulatus*, Sow. Loc. Cime de Coss, Col de Monnier.

JURASSIC PERIOD—*continued.*

LIASIEN, D'Orb. Marlstone (Phil.) *Upper bed*—Blackish compact limestone Inc. from 75 to 90 deg. N.; 100 metres thick; poor in fossils. *Amm. lunula*, Zeit. Loc. Mount Monnier, Fontan.

Lower bed—Metamorphic limestone, black marble, with white sparry veins, Coprolites. Loc. Chaudan, Mount Monnier.

SINÉMURIEN, D'Orb Lower Lias Shale (Phil.) *Upper bed*—Lead grey coloured limestone, breaking up by exposure to the atmosphere. Inc. 80 to 90 deg. N.; 30 metres thick; poor in fossils. *Ostrea arcuata*, Brong. Loc. Mount Vanque, Mount Monnier.

V. TRIASSIC PERIOD.

SALIFERIEN, D'Orb. Red Marl (Murchison). *Upper bed*—Salt Springs and Saline Alluviums. Loc. Amen, Sausse, Roquette, Tignet.

CONCHYLIEN, Brong. New Red Sandstone (Murch.). *Upper bed*—Compact Limestone, breaking up by exposure to atmosphere. Loc. Mandelieu, Pégomas, Iles Lérins.

VI. PALÆOZOIC PERIOD.

PERMIEN, Murch. and Vern. Lower Red Sandstone. *Upper bed*—Violet coloured fine Sandstone of the Vosges, etc. Petrosiliceous rock, without fossils. Loc. Belvedere, Val de Spaillars.

CARBONIFERIEN, D'Orb. Carboniferous Limestone. *Upper bed*—Red tinted compact Limestone in amorphous masses. Loc. Summit of Mount Bégo.

— *Middle bed*—Red and gray slaty schists with iron. Loc. Boquebilliere Fontan.

— *Lower bed*—Limestone with quartzose conglomerate, etc. Loc. Foot of Mount Bégo.

DEVONIEN, Murch. Old Red Sandstone (Murch.). *Upper bed*—Fetid grey limestone or greywacke. Loc. Mount Raus, Saorge Breil.

SILURIAN. Upper Silurian (Murch.). Black friable Marly Schists. Loc. Col. Formosa, foot of Mount Abyme.

VII. PERIODE AZOIQUE STRATIFIÉE, D'Orb.

TALCITES, D'Orb. Talc plastique. *Upper bed*—Aluminous Talc, etc. No fossils. Loc. Col. de la Querce, baisse de St. Véran.

— *Lower bed*—Calcareous Talc, siliceous, compact, antimonius (serpentines, chloromélanite). Loc. Vallauris, Biot, St. Anne, Riofredo.

MICACITES, D'Orb. Mica schists, Syenites in large masses, in thin layers or schistose. Mica, black felspar with siliceous paste. Loc. Col long, St. Anne, Cannes.

GNEISS, Brêchiole, red porphyry. *Upper bed*—Compact red porphyry: crystalline rocks. Loc. Croisette, Cannes, Esterel.

— *Middle bed*—Coarse Gneiss, or Gneiss with large grains, crumbling by exposure to the atmosphere; white quartz. Black felspar. Loc. Mount Malcontourn.

— *Lower bed*—Fine Gneiss; or Gneiss with fine grains, white or with black spots. Loc. Salése, Trinité, Borréon.

AZOIC PERIOD. Rocks not stratified. White snow-coloured Granite, with fine grains, spotted by small dots of black felspar. Alpine type. Loc. Mount Gelas, St. Martin Lantosque.

(*To be continued*).

III.—NOTES ON VARIOUS SPECIES OF *CTENODUS* FOUND IN THE LOW MAIN COAL-SHALE, NEWSHAM COLLIERY, NORTHUMBERLAND.

By T. P. BARKAS, F.G.S.

(PLATE IX., Figs. 1 and 2).

FOR many years the various Coal-shales and other strata associated with the Coal-seams of Northumberland have been known to be rich in the remains of Plants, and the majority of the *specimens* which are illustrated in Lindley and Hutton's elaborate

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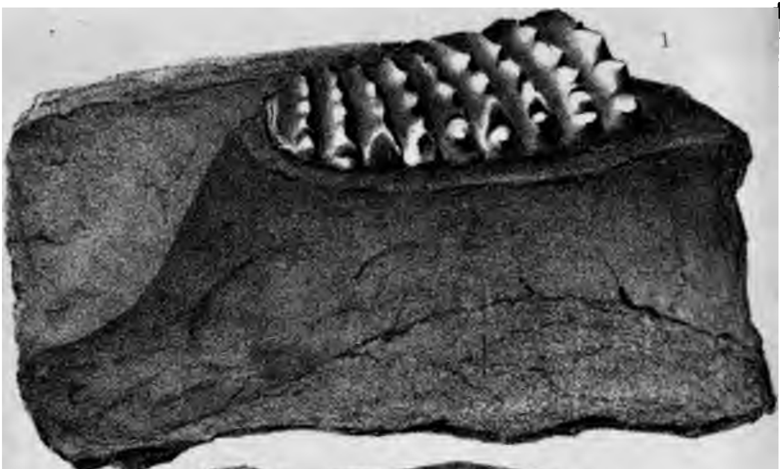
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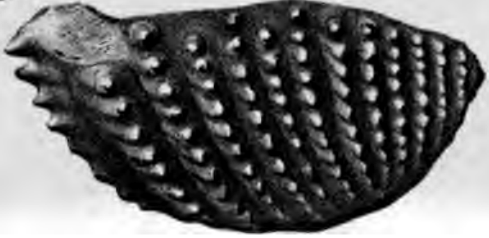
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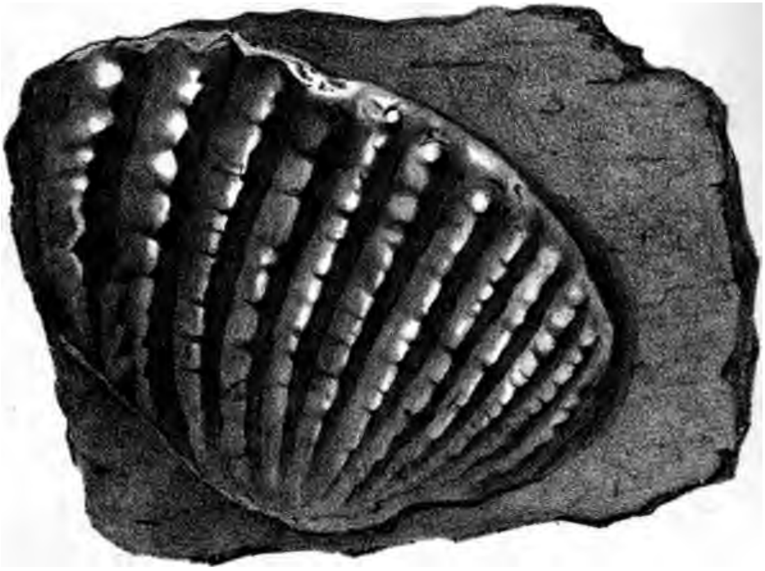
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Palatal Teeth of Ctenodus
Natural Size

work on the Flora of the Coal-period were obtained from collieries in Northumberland and the adjoining county, Durham. It is only within the last few years that close attention has been directed to the investigation of the fauna of the Northumberland coal-fields. The first systematic investigator of the fauna of the Carboniferous period in this locality was Mr. Thomas Atthey, late of Cramlington, now of Gosforth; and within the last few years Messrs. Kirby, Sim, Taylor, and Craggs have each secured good collections of the Carboniferous fossils.

Among the most numerous animal-remains discovered in the Northumberland Coal-measures are those of various species of fishes of the genus *Ctenodus*, of which as yet little is positively known, further than that their oral armature was of a very peculiar description, and that their opercular plates and head-bones to a great extent resemble those of *Dipterus*, as described by Hugh Miller.[1] As the species to which I am about to refer have been previously described in the "Annals of Natural History" by Messrs. Hancock and Atthey, but have not been figured, I desire to direct the attention of the readers of the GEOLOGICAL MAGAZINE to figures of the largest and most rare of the species obtained in our Northern coal-fields.

In the articles just referred to there are seven species described, six of which are new and one, *Ctenodus cristatus*, which is at present in the Leeds Museum, was described and figured by Prof. Agassiz in his "Poissons Fossiles," vol. iii. p. 137, pl. 19, fig. 16. Prof. Agassiz figures four additional species in his "Monogram des Poissons Fossiles du Vieux Grès-rouge," none of which correspond with those referred to, which have by Messrs. Hancock and Atthey been named *Ctenodus tuberculatus*, *C. corrugatus*, *C. obliquus*, *C. elegans*, *C. imbricatus*, and *C. ellipticus*.

Ctenodus cristatus is very rare in our coal-shale; I have only succeeded in obtaining one specimen, but that fortunately has associated with it a perfect sphenoid bone, a beautiful opercular plate, and several of the head bones of the fish. At the edge of the slab containing the specimen there are impressions of three tubercles, which have been made by the tubercular prominences of another tooth, but unfortunately the specimen which left the impressions has not been obtained. The tooth now in my possession is two inches long, 1¼ inch broad, has twelve ridges strongly marked with sharp-pointed denticles, and bears a considerable resemblance to the specimen in Agassiz "Poissons Fossiles." The opercular plate is thick and strong, and is rather deeply marked with vermicular reticulating lines, somewhat resembling those which cover the maxillary bones of *Rhizodopsis*, and which underlie the polished covering of the scales and bones of *Megalichthys*; it is 1¾ inch long, and 1⅜ inch broad. I have in my possession a large, nearly circular, opercular plate, which is supposed to belong to one of the *Ctenodi*; it is 6¼ inches in its longer diameter and 6 inches in its narrower, and is about ⅜ of an inch thick at its thickest part. To what species this large operculum belongs I do not know; but assuming that it bears the same proportion to the size of the fish that the opercular plate of *C. cristatus* does to the fish to which it belonged, it must have been, according to the estimation of competent palæontologists, little short of ten feet in length. I have not yet discovered any palate teeth of a size proportioned to opercular plates so large as that just described; the largest tooth I have obtained, and, I have reason to believe, the largest that has been obtained anywhere, is a palatal tooth, which, provisionally, I ascribe to *Ctenodus tuberculatus*, although it in some respects differs materially from the description of that species given in the "Annals of Natural History."

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[1] "Footprints of the Creator," p. 58, new issue.

In order to afford an opportunity of estimating the appearance and size of teeth of this species, figures are annexed (see Plate IX.) of a palatal (Fig. 2) and mandibular tooth (Fig 1).

Fig. 2 represents a palatal tooth, and Fig. 1 a mandibular tooth (both of the natural size) with the mandible attached and *in situ*. The figures represent teeth belonging to the same species, and although they were not obtained on the same day, it is not improbable that both belonged to the same fish—their sizes, state of preservation and general appearance so closely resemble each other. Of the teeth of *C. tuberculatus* I have but three specimens, those figured and a fragment of a mandibular tooth which has eight perfect ridges, one of which I have removed for the purpose of making a section for microscopic examination. The bony texture of the tooth is exceedingly hard, the base being very open and cellular; but the exterior grinding portion being dense, thick and hard, it must have offered a formidable surface for crushing food during the lifetime of the fish. This excessive hardness of the outer enamel will account for the fact that the greater proportion of the palatal and mandibular teeth that have been found are as perfect, sharp, and well-defined as though they had never been used. The cellular portions of the teeth and plates of attachment of the *Ctenodi* bear considerable resemblance to the *Pleurodi* and *Pœcilodi* in their microscopic structure.

Of *Ctenodus corrugatus* I have not found a single specimen; the only remains of that species with which I am acquainted being a palatal tooth, which is preserved in the Museum of the Natural History Society of Newcastle-on-Tyne. The tooth is crossed by nine irregular, corrugated ridges, and is remarkably unlike the teeth of any other known species of *Ctenodi*. I have obtained about two hundred specimens of *C. elegans*, *C. obliquus*, *C. imbricatus*, and *C. ellipticus*, several of which have been presented to museums and private palæontologists. In my collection there are also three specimens with four ridges, probably new to science, and many specimens respecting which I have not yet obtained any satisfactory information.

EXPLANATION OF PLATE IX.—Figs. 1 and 2.

Fig. 1.—Mandibular tooth of *Ctenodus tuberculatus*.
„ 2.—Palatal tooth of same,
both from the Coal-shale of Newsham Colliery.

IV.—NOTE ON A TOOTH OF *CTENODUS TUBERCULATUS* IN THE BRITISH MUSEUM. BY THE EDITOR.

(PLATE IX. Fig. 3.)

Having had our attention directed by Mr. Barkas's paper to the specimens of this genus in the National Collection, and compared Mr. Barkas's figures with Mr. T. Atthey's description of *Ctenodus tuberculatus* [see "Annals and Magazine of Natural History" (4th series), Feb. 1868 (p. 83)]; Mr. W. Davies having also kindly pointed out to us a small but very perfect palatal tooth (see Plate IX. Fig. 3), probably from the Coal-measures of Carluke (from the collection of the late Mr. Alexander Bryson of Edinburgh), closely agreeing with Mr. Atthey's description in all its characters; we have thought it well deserving of a place in our Plate.

At the same time we may state that there is no reason why Figs. 1 and 2 on Plate IX. may not also belong to the same species as suggested by Mr. Barkas, as the teeth of this genus appear to be subject to considerable individual variation.

The annexed description is taken from Mr. Atthey's paper above referred to (*op. cit.* p. 83):—

"*Ctenodus tuberculatus*, n. sp.—Tooth plate-like, thick, with an irregular ovate outline, $2\frac{3}{4}$ inches long, $1\frac{6}{8}$th inch broad, the narrow end posterior; the inner margin gibbous or angulated in the centre; the outer margin a little convex; the surface is slightly convex, and is furnished with twelve or thirteen deep, sharp, parallel, approximate ridges, which are strongly tuberculated towards the outer margin, and divided by narrow, deep, angulated grooves; they are arched posteriorly and enlarged towards the exterior border, but do not at all assume a radial arrangement, the anterior ridge, which is wider than the others, is reflected and prolonged for some distance beyond the outer margin; the tubercles are conical, with obtuse points; those next the external border are coated with shining enamel, and are well produced."

Besides the specimen figured (Plate IX. Fig. 3), there are in the British Museum several fine teeth belonging to this genus (probably also from Carluke), and a portion of the head and lower jaw with both the upper teeth and one lower (or mandibular tooth) *in situ* from the Coalfield of Airdrie.

V.—THE LEAD-BEARING DISTRICTS OF THE NORTH OF ENGLAND.[1]

By Prof. MORRIS, F.G.S., etc.

THE district to which attention is directed is situated in the centre and the most elevated part of Great Britain, which is thickly inhabited by an industrial population, many of whom are occupied in the working of Lead-mines. The Agent's house of the Beaumont

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[1] Being the substance of a Lecture delivered before the Geologists' Association at University College, London, by Prof. MORRIS, F.G.S., the President of the Association, on June 4th, 1869.

Mines is at an elevation of 1400 feet above the sea, Kilhope Law rises 2206, while Crossfell (capped by Millstone Grit) attains a height of 2901 feet; Dufton Pike 1575 feet, and the Cheviots 2676 feet, the three counties of Northumberland, Cumberland, and Durham meeting at Rampgill Head; Durham, Yorkshire, and Westmoreland at Cauldron Snout. This elevated district, bounded on the east by the Tyne and Wear Coal-field, and on the west by the Whitehaven field, chiefly consists of the Carboniferous rocks, and presents varied physical features. The Penine chain, of which Crossfell is a part, extends from the borders of Scotland to Derbyshire, and from its westerly trend it forms the watershed, whence on the east side fall the waters of the Tyne, Wear, and the Tees. The country presents a varied aspect; to the east are broad low plains, succeeded by rolling hills and dreary elevated moors, followed by a more hilly and more rugged district, rising gradually on the east side of the Penine chain, and descending more steeply on the western side. These, together with the character of the rocks, influence the vegetation of the country, as shown by the "basset" of the Great Limestone, which forms almost the boundary of cultivated land and human habitations. Above it (as Mr. Sopwith observes) are more or less brown and dreary moors, and below it the hill-sides present a green surface and flowery meadows. The counties of Northumberland and Durham occupy about 2905 square miles, three quarters of which belong to the Carboniferous strata.

The geological structure consists of more or less altered aqueous rocks with others of igneous origin, some anterior, some probably contemporaneous, and others posterior to the great mass of the stratified rocks. The aqueous include the Silurian, Devonian, Carboniferous, Permian, and Triassic. The igneous are Porphyry, and Basalt or Dolerite. The Silurian consists of schists, grits, and slates, altered and much plicated or folded, containing very few fossils, except *Graptolites*; it attains an elevation of 1700 feet. The Old Red attains an elevation of 200 to 700 feet, and is about 500 feet thick, yielding a few fishes (*Holoptychius*, &c.); it is unconformable to the beds below, and conformable to the Carboniferous, of which it forms the base. This unconformity is well seen at Siccar Point, near St. Abb's Head, Berwickshire; also at other places on the way to Canrobie. The Carboniferous rocks, which are about 7000 feet thick, and occupy three-quarters of the area, include the Tuedian, Scar and Yoredale series, Millstone Grit, and Coal-beds. The Tuedian consists of sandstones, shales, and limestones, sometimes magnesian, but no coal; it is about 1000 feet thick, with indications of Estuarine conditions, and contains remains of plants, shells, Cephalopods, some fish, but neither Crinoids nor Brachiopods.

With regard to the Carboniferous Limestone, great differences are observed in tracing this deposit from South to North. It is very uniform in the South of England, North and South Wales, and in Derbyshire. It is wanting in South Stafford, where the Coal-measures overlie the Silurian rocks, but in Yorkshire a change takes place. A line drawn from Jervaux Abbey, on the Yore, Yorkshire, through

Kettlewell and near Malham, to Lancaster, separates, according to Phillips, the Yorkshire Limestone tract into two well-contrasted parts,—the southern type, in which the Lower Limestone Group is nearly undivided, and the Upper Limestone Group thin, and with interbedded shales. In the northern type the Lower Limestone Group is divided by shales, sandstones, &c.; and the Upper Limestone Group, about 1000 feet thick, is complicated, and consists of limestone, coal, flagstone, and shales, alternating with each other. In the more northern counties a still greater complexity is observed, as in Northumberland, Durham, and Cumberland, showing a transition to the Scottish type. Thus, north of the Tyne and the great 90 fathom dyke, the Carboniferous Limestone is divided by Mr. Tate into two series—the Lower Carbonaceous, the Upper Calcareous, the total thickness being about 2600 feet, of which 1400 are sandstone, 900 shale, 230 limestone, 70 coal; the lower, about 900 feet, extends from the Tuedian to the Dun limestone, contains little limestone (about 20ft.), but eight seams of good workable coal, of which the Scremerston and Cooper Eye coals are the best. The Upper series, 1700 feet thick, is distinguished by its workable limestone (about 200 feet thick), interstratified with sandstone, shale, and coal, some of fair quality, as the Shilbottle and Licker coals, and the Beadnell about 5 feet thick, but others poor and thin. South of the Stublick dyke the whole series, according to Forster's section, has a thickness of 2080 feet, of which 820 are siliceous, 790 argillaceous, and 470 calcareous. The series has been divided into two groups, the lower, below the Whin Sill, comprises the Scar Limestone series of Phillips, crops out in Cumberland and Westmoreland, and includes the Melmerby limestone. The Upper, comprising the Yoredale series, includes the strata between the Whin Sill and the Fell Top limestone, of which the larger portion consists of argillaceous and siliceous sediments, with about 180 feet of calcareous strata, and 4 feet only of coal.

The following table of the relative thickness of the Lead Measures (Yoredale series, Phillips) from the Fell Top Limestone to the Tyne Bottom Limestone above the Whin Sill, shows the principal mineral characters and their alternation, and the predominance of mechanically formed over chemically and organically formed strata, arranged from W. Forster's "Section of the Strata," p. 165 *et seq*:—

ARGILLACEOUS AND ARENACEOUS.	FEET	CALCAREOUS.	FEET
Crow Coal, Hazle, Plate, Slate Sill, Firestone, Pattinson's Sill	330	Fell Top Limestone...	4½
Plate and impure Coal	68	Little Limestone	3
Tuft, Hazle, and Plate Beds	102	Tumbler Bed and Great Limestone, with three flat veins	63
Hazle and Plate	54	Four-fathom Limestone	24
Hazle and Plate	46	Three-yards Limestone	9
Coal, Plate, and Hazel	30	Five-yards Limestone	6

ARGILLACEOUS AND ARENACEOUS.	FEET	CALCAREOUS.	FEET
		Scar Limestone...	30
Hazle, Plate, and Coal	37		
		Cockle-shell Limestone	2
Hazle and Plate	102		
		Tyne Bottom Limestone...	24
Whetstone Bed, etc....	3		
Whin Sill.			

Turning now to the igneous rocks and commencing with the Whin Sill, so called from its sometimes being apparently parallel to the other strata, but really varying as much as 1000 feet when traced over the whole area; it is from a few to 200 feet thick in Teesdale, giving a picturesque character to the scenery, and may be traced through Northumberland, into Durham, Cumberland, and Yorkshire. Its age is anterior to the fissures holding the lead, as they traverse it, and also to the Penine fault, which may be contemporaneous with the veins, the force producing the one causing the other. The whin is a dolerite of augite and felspar, with titano-ferrite. Many dykes also traverse this district. Two are comparatively well known—the Hett dyke traverses the Mountain Limestone, Millstone Grit, and Coal-measures, and the Cockfield dyke, about 70 miles in length, passing through the Mountain Limestone, Millstone Grit, and Coal-measures, and New Red Sandstone. This district is traversed by many Faults, which have had a most important influence on the physical character of the district, and to some extent upon the industrial resources. The 90 fm. dyke (east and west), Tynedale fault, and Stublick dyke, throw down the coal to the north and west—hence the Stublick, Midgeholm, Conewood, and Hartley Burn coal-fields. The Penine fault has a downthrow to the west of 3000 feet, which, with the Craven fault, so materially influences the physical features of the district traversed by them. The Burtreeford dyke is a north and south fault, crossing the lead-mine district from the Vale of Tyne to the Tees, affecting the Yoredale rocks only, and has an upthrow to the west. The Butterknowle dyke runs east and west in the county of Durham, and throws the strata down to the south. The Tees Valley fault is an upthrow of about 45 fathoms to the west.

The mining country occupies about 400 square miles, and includes the district of the head waters of the Tyne, Wear, and the Tees; the chief lead district comprising Derwent, East and West Allendale, in Northumberland; Weardale and Teesdale, in Durham; and Alston Moor in Cumberland. The geological formation is the Yoredale series, or Mountain Limestone of Phillips, while the *lead* veins further west in Cumberland are found in the Silurian and metamorphosed rocks, each district having a somewhat distinct association of minerals. Discussing the question, What is a vein? it is worthy of remark that the rich or right-running veins run a little north of east and south of west, the cross-veins bear nearly north and south, besides which are quarter-point veins bearing between the two. When three veins lie near each other the two outer veins are termed north and sun veins respectively. The same vein has requently many names, according to the lease length, which is about 200 yards. Cross veins commonly alter right veins, but not always as at Scaleburn cross vein), and right veins are often split, and ometimes lost in cross veins. The "hade" is the inclination; the pper side is the "hanger," and the under side the "ledger cheek." n Weardale the hade is south, in Allendale and Alston to the north ut it varies with the nature of the strata. The throw of veins is a ore or less vertical disruption of strata, but this is variable. There s, however, a connection as well known to practical men between he hade and throw of veins—if the throw is up to the south, the ade is to the north and contrariwise. Veins are of different kinds, as ake, pipe, strings, gash, flat veins. The rake vein is the most common, nd occupies a fissure extending downwards a considerable distance, nd may have opposite, similar, or dissimilar cheeks, and thus the ein is more or less productive, and is irregular in size. The suboined shows the character of the lode according to the nature of he cheeks, although this is subject to modification:—

Argillaceous	Vein unproductive	Argillaceous.
Gritstone	Vein irregular	Grit or limestone.
Argillaceous	Vein poor	Grit or limestone.
Limestone	Vein favourable	Limestone.

A gash vein is a fissure which contracts downwards. The "hade" r inclination is mostly in the softer beds, and when two veins meet hey are generally enriched. Regular veins have a slight throw, nd the size of veins depends on the nature of the rock, being generally wider in limestone. A rider is the stony mass found in the vein, and divides it. A pipe is an irregular cavern, extending downwards, and s more or less tubular. A flat vein is a dilated vein in a space beween two strata of stone, and resembles a coal seam, and inclines with the strata. With regard to the difference of produce in the arious strata, the great limestone, at least in the Alston district, eems to be the most productive, although in other localities other strata are also productive. Mr. Forster mentions that the mines differ n each side of the Burtreeford dyke, being softer on the east side, nd harder on the west, where they contain more blende and rider. The hief minerals yielding lead are galena or sulphide, cerusite or carboate, and oxide of lead. The associated minerals are blende, calamine, luor, barytes, quartz, calc- and pearl-spar. It is said the cubical galena yields a purer lead than the wavy galena, which contains ntimony. In the Cumberland district the phosphates and arseniates, with cerusite, linarite, and caledonite, or the coloured ores, are the hief lead ores, as at Roughtengill and Drygill.

Composition and character of the principal minerals from the disricts above mentioned:—

			Hardness.	Sp. Grav.
Galena	Sulphide of lead	Cubical	2·5 to 2·7	7·5
Cerusite	Carbonate of lead	Rhombic	3 to 3·5	6·4
Minium	Oxide of lead	Pulverulent	2 to 3	4·6
Blende	Sulphide of zinc............	Cubical	3·5 to 4	3·9 to 4
Calamine	Carbonate of zinc	Rhombohedral ..	4	4 to 4·4
Fluor-spar	Fluoride of calcium	Cubical	4	3·1
Heavy spar......	Sulphate of baryta.........	Rhombic	2·5 to 3·5	4·5

			Hardness.	Sp. Grav.
Witherite	Carbonate of baryta	Rhombic	3 to 3·7	4·3
Bromlite	ditto and lime	Rhombic	4 to 4·5	3·7
Barytocalcite	ditto and lime	Monoclinic	4	3·6
Pearl spar	Carb. of lime & magnesia	Rhombohedral	3·5 to 4	2·8
Pyromorphite	Phosphate of lead	Hexagonal	3·5 to 4	6·5 to 7
Mimetite Kampylite	Arsenio-phosphate, with chloride of lead	Hexagonal	3·5	7
Linarite	Cupreous sulph. of lead	Monoclinic	2·5	5·4
Caledonite	ditto with carbonate	Rhombic	2·5 to 3	6·4
Brochantite	Hyd. sulphate of copper	Rhombic	3·5 to 4	3·7

With a view to show the vast importance of the lead mines of the northern district, it is deserving of mention here that the number of mines and the amount of lead ore and silver raised in the following counties in 1867 was—

Counties.	Mines.	Lead Ore.	Silver.
Northumberland and Durham	47	Tons. 22,574	Ozs. 77,678
Westmoreland	7	2,418	25,142
Cumberland	75	5,682	31,022
Yorkshire	65	7,539	3,000

Whilst the total produce of Great Britain for 1867 was—Lead ore, 93,432 tons, of the value of £1,158,066; lead, 68,440, worth £1,337,509; silver, 805,394 ozs., worth £215,400: showing that Northumberland and Durham raise nearly one-quarter of the total produce of the entire kingdom.

In conclusion the writer begs to acknowledge his obligations to Mr. T. Sopwith, F.R.S., and Mr. R. W. Bainbridge, of Middleton, for much valuable aid and information in preparing this paper, likewise to notice the general intelligence and civility of the miners, and their willingness to impart practical knowledge; and, lastly, the care which has obviously been bestowed by the large proprietors for the education and elevation of the people, and the promotion of their domestic comforts and happiness—a boon fully appreciated by them, and thus there does not appear to exist those unhappy differences between the employers and employed which in too many places are detrimental to the interests and welfare of every party.[1]

NOTICES OF MEMOIRS.

I.—The Miocene Flora of North Greenland.

IN March last, a paper by Prof. Oswald Heer, of Zurich, was read at the Royal Society, being an account of the examination of the fossil plants brought home from Greenland in the autumn of 1867 by Mr. Edward Whymper.

Our readers will remember that Prof. Heer's work, "Flora Fossilis Arctica," was to a great extent a description of the fossil remains brought from Atanekerdluk, in Greenland, by Sir F. L. M'Clintock and others, most of which are deposited in the Museum of the Royal

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[1] Revised by the Author, and reprinted from the *Mining Journal*, June 12, 1869.

Dublin Society. In order to obtain materials for a more thorough investigation of the district, application was made to the British Association at Nottingham by Mr. R. H. Scott, and a grant of money was made to a committee for the furtherance of this object. Mr. Whymper was one of the members of this committee; and as he had previously had the intention of visiting Greenland for the purpose of a geographical exploration, he consented to accept of the grant conditionally on his being able to collect geological specimens. The grant was afterwards most liberally increased by the Government Grant Committee of the Royal Society. Mr. Whymper engaged Mr. R. Brown to assist in the work, and ultimately brought home a large and valuable collection of fossil plant remains.

The localities whence these were obtained were three in number—(1) Atanekerdluk, the original locality described in the Flora Arctica. This place is situated on the mainland of Greenland, on the shore of the Waigat Strait, in lat. 70° N. (2) Ujararsusuk. (3) Kudlisch. Both these localities are on the island of Disco itself, on the opposite shore of the Waigat to Atanekerdluk. Coal has long been worked at various spots along this eastern shore of Disco, and more than sixty years ago Sir Charles Giesecke noticed impressions of leaves in the sandstone underlying the coal.

The specimens on their arrival in Europe were sent to Prof. Heer at Zurich, and on their return to London, a complete series, comprising all the figured specimens, was presented by the Committee to the British Museum.

The general conclusion to be drawn from the notes made on the geology of the district is that on both sides of the Waigat the sedimentary rocks are covered with Miocene deposits pierced by volcanic rocks, which appear in places as thick beds of basalt and trap. The botanical results of the expedition are very valuable. Fourteen species were discovered in Disco, among which *Sequoia Couttsiæ*, so common in our own Bovey Tracey beds, is noticeable. The most important find here was the cone of Magnolia, of which two specimens were secured. Leaves referred to this plant had been previously found at Atanekerdluk, and the discovery of the fruit is consequently very satisfactory. The number of species brought from Atanekerdluk is 73, 25 of which are new to Greenland. Among the most interesting of these are the flowers and fruit of a chestnut, showing that the deposit containing them must have been in process of formation in spring as well as in autumn.

The Miocene plants discovered in Greenland have now reached 137 species, making 194 in all, belonging to the Arctic Miocene Flora; 46 of the Greenland species (one-third of the total number) are also found in the Miocene of Europe. The beds are therefore Lower Miocene. Four species are also met with at Bovey Tracey. As regards the determination of the species, Prof. Heer says—

17 species among the Greenland specimens are represented by *leaves* and *organs of fructification.*

10 species are represented by *leaves* in Greenland, their *organs of fuctification* occur elsewhere.

17 are species of which the *leaves* are so marked that their identification is quite certain.

5 *Cryptogams* have been satisfactorily recognized.

Accordingly, though it must be allowed that the systematic position of many of the plants from North Greenland is still uncertain, yet the considerable number of absolutely identified species which can be produced enables us to form a clear idea of the Miocene Flora of North Greenland.

We are glad to hear that the Swedish Polar Expedition of last summer has brought home a rich harvest of Miocene plant-remains from Spitzbergen, which have been entrusted to Prof. Heer for examination and description.

II.—MUSÉE TEYLER, CATALOGUE SYSTÉMATIQUE PAR T. C. WINKLER. Suppl. I. 1868.

THE additions to the Palæontological collection of this valuable Museum are noticed in the present Supplement, which is a continuation of the Catalogue previously edited by the author, who succeeded Van Breda as Curator of the Museum. The species are classed zoologically under the three great geological periods, and amount to 12760.

III.—DES TORTUES FOSSILES CONSERVÉES DANS LA MUSÉE TEYLER, PAR T. C. WINKLER. 1869.

THIS Memoir consists of 27 folding lithographic plates, with 151 pages of descriptive letter-press, illustrative of the species of fossil turtles in the Teyler Museum at Harlem, of which the collection contains a considerable number. It is from the pen of the able Curator, Dr. Winkler, and contains not only detailed descriptions, but critical remarks on the species. In noticing the *Chelone longiceps* of Owen, Dr. Winkler cites it as a synonym of *Emys Parkinsoni*, Gray, as he considers, from certain characters alluded to in the text, it should be placed with the latter instead of the former genus. There is some confusion about the synonymy of this species, as may be seen by comparing the works of Bronn and Pictet.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—I. May 26th, 1869. Papers read:—

1. "Notes on the Geology of Cape York Peninsula, Australia." By Alex. Rattray, M.D. Communicated by the President.

The author stated that the Eastern mountain-range of Australia is produced through and forms the axis of the peninsula of Cape York; it consists of various granites and porphyries, gneiss, felspathic and quartzose rocks. In Cape York itself the rock is a porphyry, with numerous crystals of yellowish quartz. Resting on the flanks of this axis are beds of sandstone, regarded as of Carboniferous age by the Rev. W. B. Clarke, and referred to the Oolite by

Prof. M'Coy. The surface-rock in the neighbourhood of Cape York is an ironstone, varying from a light friable clay to a dense ferruginous conglomerate, sometimes nodular and magnetic; an average specimen contained 39·69 per cent. of iron. This deposit extends at least as far south as the Mitchell River, on the west side of the peninsula, and as far as Weymouth Bay on its east side. It is regarded as Post Tertiary by Mr. Clarke. Between this and the igneous rock intervenes a local deposit of coarse quartzose sandstone, which forms bold cliffs in Albany Island and on the opposite coast of the mainland. No boulder-deposits or glacial markings were detected by the author.

The author referred to the occasional occurrence of earthquakes in Eastern Australia, and to the evidence that at least the North-East of that continent is being slowly elevated, namely, the occurrence of water-worn caves above high-water mark in Albany Island and on the opposite coast, the existence of extensive plains covered with sand-dunes, especially towards the north of the peninsula, and the gradual emergence of islands in the line of the great Barrier Reef.

2. "On the Formation of the Chesil Bank, Dorset." By H. W. Bristow, Esq., F.R.S., F.G.S., and Wm. Whitaker, Esq., B.A., F.G.S.

The authors first described the general character of the bank, and noticed the previous hypotheses that have been suggested to account for its formation. They maintained that it had been formed as an ordinary shingle-beach banked up against the land, and afterwards separated by the wearing action of the small rivers flowing to the sea at this part. They stated that west of the Chesil Bank there are cliffs of greater or less elevation, through which small streams flow down to the shore, when they turn a little eastward between the beach and the land, and then filter through the shingle without breaching it. The effect of a similar river-action on the low shore behind the Chesil Bank would, in the authors' opinion, be to cut such a channel as that of the Fleet, by which this bank is separated from the shore.

DISCUSSION.—Mr. Evans suggested that tidal action may have assisted materially in the formation and widening of the Fleet, which may have originated in a breach between Portland Island and the mainland.

Mr. W. Boyd Dawkins instanced a case at Pagham Harbour, where a bank of shingle was advancing and diverting the course of a stream to the East. He also instanced the shingle-beach at Shoreham, and argued in favour of the marine origin of the channel.

Mr. Flower inquired as to the rocks from which the pebbles had been derived, and suggested that the examination of this deposit might throw light on the origin of such formations as the Woolwich and Reading Beds.

The President observed on the similarity of the operation of the sea on such beaches to that of winds on sand-dunes, which travel forward during high winds and storms, and inquired why the beach still continued so straight without trending to the north when no longer supported by the land, and to the east of Abbotsbury.

Mr. Whitaker did not regard the cases at Pagham and Shoreham as analogous with that of the Chesil Bank, inasmuch as the point of the shingle-banks did not touch the land like the Chesil Bank, which rests on high land at Portland. The pebbles were of all rocks, and derived from the westward. There were no data by which to judge of the travelling landwards of the beach, which was, however, far from straight.

3. "On a Raised Beach at Portland Bill, Dorset." By W. Whitaker, Esq., B.A., F.G.S.

The author stated that a deposit of shingle occurs upon the cliffs of the south-east part of the isle of Portland, extending from Cave Hole to the Bill. At the former place it is from 30 to 40 feet above the sea, and is capped by a considerable thickness of angular "head." Further south there is less of the "head." The shingle consists of pebbles of limestone, flint, and chert; and the deposit contains shells of *Littorina littorea* and *littoralis*, *Patella vulgata*, and other species. Near the beacon these species, with *Purpura lapillus*, occur. To the west of the Bill the shingle is partly covered by a yellowish-brown loam, containing land and freshwater shells, such as *Bythiniæ* and *Pupæ*.

Discussion.—Sir Charles Lyell could not entertain a doubt as to this being a true raised beach. He had found in it more species of shells that those mentioned. He thought that the existence of this beach, proving an elevation of the land, ought to be taken into account in any theory as to the origin of the Chesil Bank.

Mr. Prestwich mentioned that at one spot the number of young shells in the raised beach was remarkably great as compared with that of older shells.

Mr. Whitaker was inclined to regard this beach as of the same date as that at Torquay, with which it is about on the same level. Its absence at intermediate portions of the coast showed that there had been time for considerable changes along the coast since its deposition.

4. "On the occurrence of *Terebratula diphya* in the Alps of the Canton de Vaud." By E. Tawney, Esq., F.G.S., with a Note by T. Davidson, Esq., F.R.S., F.G.S.

The author recorded the occurrence of *Terebratula diphya* in a block of Oxfordian limestone derived from the ridge of the Vanil Noir, near Paray Charbon. No Neocomian beds occur within a distance of several miles. The block had merely fallen, and had not been transported. The author indicated that this result is in opposition to the views of M. Hébert, who maintains the identity of *T. diphya* and *T. diphyoides*, and refers all the beds containing these fossils to the Neocomian series.

Mr. Davidson, in his note, indicated the distinctive characters of *T. viator*, Pict. (=*diphya*) and T. *diphyoides*, and confirmed the author's opinion as to its Jurassic age.

Discussion.—Mr. J. W. Judd thought that the break that usually existed between the Neocomian and Jurassic beds proved that there must have been intermediate marine deposits, and that some beds in the Carpathians were rightly attributed to the intermediate age. Possibly, therefore, diphyoid *Terebratulæ*, commencing in the Jurassic and continuing in the Tithonian, still lived on in the Neocomian period.

5. "On a new Labyrinthodont from Bradford." By T. H. Huxley, LL.D., F.R.S., President, with a Note on its locality and stratigraphical position, by Louis C. Miall, Esq.

The Labyrinthodont nature of this fossil was said to be proved by the characters of the vertebræ, ribs, and ventral armour. It exhibits portions of both jaws, which bear close-set teeth of nearly equal size, nearly circular in section, and slightly recurved at the apex, which is obtusely pointed. The surface of the upper jaw shows a pitted sculpture. The ventral armour consists of oval plates, traversed obliquely by a convex ridge, dividing them into two unequal parts.

They are supposed by the author to have overlapped each other, so as to show little more than the surfaces of the oblique ridges. The author stated that this Amphibian appears to be most nearly related to his genus *Pholidogaster*, but that it differs therefrom in the form of the vertebral centre, and in the nature of the ventral armour. He proposed to give it the new generic name of *Pholiderpeton*.

Mr. Miall stated that the fossil described by Professor Huxley was obtained from the Black Bed or Royd's Coal at Toftshaw, near Bradford, and remarked that the Amphibians of the Coal-measures appear to have been not only specifically numerous, but individually abundant. He also noticed the difficulty of defining exact horizons within the Coal-measures.

Discussion.—Mr. Salter observed that, with both plants and mollusks, it appeared to him that there were some which were eminently characteristic of different horizons in the Coal-measures, which were to be traced over large areas. It was possible that the same might prove to be true with regard to vertebrate animals.

Dr. Duncan called attention to the conditions of life necessary for such an animal, which could not have been in accordance with the commonly received views of the character of the Carboniferous period.

6. "On the Maxilla of *Megalosaurus*." By T. H. Huxley, LL.D., F.R.S., President.

The author stated that the specimen which he was about to describe, belonging to Mr. Abbay, of King's College, was the first example of the upper jaw of *Megalosaurus* that had ever been seen. It showed the left side of the jaw, measured nearly 18 inches in length, and 4¼ inches in depth anteriorly; the posterior part was produced into a thin and probably free process. The author described the general form of the nasal and orbital opening, as indicated by the characters of the specimen, and stated that the anterior part of the jaw exhibits no suture indicating the separation of the premaxilla from the maxilla. The teeth were stated to be few in number, but very large, the part concealed by the jaw being exceedingly long. One tooth, exposed in its whole length by the breaking away of the bone, measured 6·4 inches, of which the crown formed 2·6 inches.

Discussion.—Mr. Boyd Dawkins made some remarks as to the stratigraphical range of *Megalosaurus*. The oldest example with which he was acquainted was a tooth from the Lias of Lyme. It occurred also in the Lower Oolite of Dorset. Higher up it was found in the Kimmeridge Clay, and again in the Tilgate Beds of the Wealden. He had, however, himself found it in the Wadhurst Clay, above the Ashdown Sands, near Battle. He had also seen remains in still higher beds, possibly of Lower Greensand age, at Potton, but in this case the bones were probably derivative. An animal with almost identical teeth, the *Teratosaurus Suevicus* of Von Meyer, occurred in the Lower Keuper, and possibly might belong to the same generic form.

The President agreed that the Dinosaurians had occurred in the Trias, and that he was quite prepared for an extension of the family into earlier beds.

II. June 9th, 1869.—Papers read: 1. "Notes on the Sutherland Gold-fields." By the Rev. J. M. Joass. With an Introduction by Sir R. I. Murchison.

Sir R. I. Murchison, in introducing the Rev. J. M. Joass to the meeting, called attention to the general geological structure of the counties of Sutherland and Ross, and especially to the circumstance that the summits of the mountains of that region are situated within a few miles of the western shore, forming a steep escarpment to the west and a long slope to the east, across which the disintegrated materials of the great mass of these mountains must have been conveyed (probably by floods carrying masses of ice), and deposited in the hollows of Eastern Sutherland. Of the rocks composing the mountains, Sir R. Murchison was inclined to regard the micaceous flags and schists overlying the lowest Silurian quartzites as the probable source of the gold found in Sutherland, and he expressed an opinion that no considerable body of rock charged with rich auriferous bands would be discovered in the North Highlands.

The Rev. J. M. Joass said that the extent of country over which gold has been ascertained to occur in the south-east of Sutherland and contiguous portion of Caithness may be stated as measuring 20 miles from north to south, and about thirty from east to west.

The prevailing rocks of the district, which are flaggy quartzites and micaceous beds dipping S.E., are now ascertained to belong to the Lower Silurian System.

The associated rocks on the S. and S.E. are, (1) Old Red Sandstone, occurring as conglomerate cliffs at Cambusmore, &c., overlain by the argillaceous shales of Sydera with fucoid plants, and the thick-bedded light-coloured Sandstones of Dornoch with *Holoptychius*: isolated mountain-masses of conglomerate occur throughout the district. (2) Along the coast from Dunrobin to the Ord of Caithness, rocks of Liassic and Oolitic age occur. (3) The igneous rocks associated with these are the porphyritic granite (*a*) of the Ord, between the Lower Silurian and Devonian rocks, and found to contain purple fluor-spar,—a fine-grained red granite (*b*) abundant throughout the auriferous district, conforming in its courses to the strike of the flaggy Gneissose strata,—and a friable granitiform rock (*c*), mostly felspathic, generally associated with the richest auriferous drifts.

In the Uisge-dubh and Allt-Smeorail, Strath Brora, gneissose and quartzose beds occur, dipping S. and S.E., associated with conformable courses of granite (*b*) and small quartz veins. The overlying drift is at bottom argillaceous, with boulders of neighbouring rocks passing upward into gravel and sand, apparently arranged by running water. On the river Helmsdale, above the junction of the Crask and Cill-Donnan roads, micaceous rocks, dipping N.E., are traversed along the strike by granite (*b*) which sometimes sends out short dykes across the beds, as if into transverse fissures, from which small veins strike off between the strata or lines of least resistance. Here a small trap-dyke crosses both igneous and stratified rocks.

Two miles to the north of this point, at the head of Suisgill burn, a favourite resort of the diggers, the white granitiform rock (*c*) appears to cross at right angles highly inclined beds of friable gneissose rock. The detritus of (*c*) occurs in patches of felspathic clay throughout the drift, and is generally associated with the richest auriferous deposits. The best washes have been found in a similar connection in Cill-Donnan burn, three miles to the S.E., and also near small quartz-veins, thinly encased in chloritic clay and traversing gneissose beds. In the two streams last mentioned, and in all the other tributaries of the river Ullie from the north, the dip of the flaggy quartzose and gneissose rocks through which they run is easterly, with a few local rolls; till at Cill-Pheader burn, 3½ miles from Helmsdale, the porphyritic rock of the Ord is reached, and continues to the coast, and the drift is no longer worth washing. Within the neighbouring district of Caithness, the metamorphosed Lower Silurian rocks appear as quartzite Mountains, some of which are capped uncomformably by Old Red Sandstone. Where flaggy gneissose beds occur, as at Allt-an-lic, the easterly dip is distinct, and persists up to the junction with the Devonian Sandstones on the S.E. These latter, at Berriedale, on the coast, dip E. and N.E., passing under the bituminous flags, which principally represent this system in Caithness.

If the gold of Sutherland be derived from the binary compound of felspar and quartz (*c*), so abundant in Suisgill and Cill-Donnan, the Caithness district does not promise to be richly auriferous; as this rock is, so far as could be seen, by no means plentiful there. Judging from the frequency with which this quartzo-felspathic rock is associated with the richest washings, and from the fact that gold has been found in small rolled specimens of stone which seem to have been derived from this rock, it is possible that it may yet be discovered to be the matrix of the gold. Hitherto, however, none has been found in rock *in situ*.

It is believed that the extent of the gold-fields will be determined by the range of the metamorphosed Lower Silurian rocks, and that its richness may, therefore, be in proportion to the degree in which it is associated with such rocks as are either eruptive, or highly metamorphosed.

The connexion of the Pictish Towers with this subject is worthy of notice. Of 60 of these forts in the county of Sutherland, 33 occur within the Cill-Donnan district. They seem to have been erected against maritime invaders, who were probably attracted by the known existence of native gold. The very numerous sepulchral tumuli of the auriferous district imply a large archaic population.

Discussion.—Prof. Ramsay regarded it as certain that no quantity of gold would ever be found in purely glacial deposits, as in such detritus specific gravity went for nothing; but when those deposits came to be sorted by water, the gold became apparent, as in this case. He agreed with the author in regarding the granites in Kildonan Burn as metamorphic rather than intrusive, and had long held this opinion. The felspathic dykes were probably due to other causes.

Mr. D. Forbes, on the contrary, regarded the granite as eruptive, and accounted for the granitic veins following the lines of stratification, inasmuch as those were the lines of least resistance. The smaller interstices caused by the intrusion of the granite would be filled with quartz veins derived from the granite, both probably containing gold. He considered that the gold had not been derived from Silurian rocks, but from the intruded granite, or from the quartz veins.

The author was inclined to regard the granite in some instances as intrusive, and in others as metamorphic.

2, "Observations on the 'Nuggetty Reef,' Mount Tarrangower Gold-field." By Dr. G. H. F. Ulrich, F.G.S.

The author commenced by indicating the positions and characters of the so-called "Nuggetty Reef," which is situated about 2½ miles N.N.W. of the little town of Maldon, about 87 miles N.W. of Melbourne, and consists of two strong quartz veins, separated by a mass of bluish-grey metamorphic sandstone. In certain places the "reef" is cut transversely or obliquely by granite bars or veins, of which the author described four, and stated that although some of them are, and all probably have been, connected with the main mass of granite, they present rather the appearance of zones of impregnation than of intrusive dykes, there being no line of separation between the quartz rock and the granite; but felspar and black mica make their appearance in the quartz, and gradually increase in quantity until the granite band is formed. The author noticed the following minerals as associated with the gold in the "Nuggetty Reef"—Iron pyrites, arsenical pyrites, magnetic pyrites, copper pyrites, galena, zinc-blende, and a compound of gold and bismuth, to which he gave the name of *Maldonite.*

3. "On the Caratal Gold-field." By Dr. C. Le Neve Foster, F.G.S.

The author stated that the Caratal Gold-field is situated about 100 miles south of the Orinoco, at a point about 75 miles above its principal mouth. The rock of the district is chiefly gneiss, with some mica-schist, hornblende schist, and granite. The gold occurs in four ways:—1, in lodes, veins, &c.; 2, in alluvial or "placer" diggings; 3, in red earth or "Tierra de flor;" and 4, in gravel and sand of river-beds. The mode of the occurrence of gold in these different places, and the various processes employed in collecting it, were described by the author, who estimates the quantities of the precious metal obtained in the Caratal district as follows:—

In 1866. . . . . 15,587 oz.
1867. . . . . 30,142 oz.
1868 (9 months). . 22,481 oz.

The greater part is obtained from the lodes.

4. "On the Geology of Guyana in Venezuela." By Ralph Tate, Esq., Assoc. Linn. Soc., F.G.S.

The author prefaced his remarks by pointing out the leading physical features of Guyana in Venezuela, and by alluding to the Geology of Venezuela to the north of the river Orinoco as determined by Mr. Wall.

Mr. Tate has ascertained the existence of an extensively developed metamorphic series, consisting of felstones, talc schists, quartzites, gneiss of great variety, hornblende slate, and amphibole rock, striking about N.E. and S.W., and dipping generally to the N.W. at a high angle. The series exhibits little disturbance, but great lithological variation; on the whole felspar predominates in the lower part, whilst hornblende increases in quantity as we ascend in the section. The felstone and talc schists, more especially the former, contain eminently auriferous lodes; the gneiss contains disseminated gold, and that to the north of Upata a rich deposit of red hæmatite and a few intrusions of greenstone.

This metamorphic series was considered to be contemporaneous with a similar series constituting the Littoral Cordilleras of North

Venezuela, the pre-Cretaceous age of which is proved by their being overlain by unaltered Neocomian beds. Indulging in speculation as to the age of these auriferous rocks, the author sought, by analogy of their mineral contents and their lithological similarity to certain auriferous and associated strata in Bolivia, to establish their Silurian age.

Skirting the Orinoco and abutting against the escarpment of the Itacama Mountains, were described the "Llanos" sandstones and conglomerates, derived from the metamorphic series. These beds, which were referred to the Upper Miocene, are in their easterly extension lignitiferous and asphaltic; and as the basin of the Orinoco is excavated in them, it was contended that the present river could have played no part in the accumulation of the materials from which the asphaltic deposits have been supposed to have originated.

5. "On the Nature and Cause of the Glacial Climate." By Jos. John Murphy, Esq., F.G.S.

The author cited the conclusions arrived at by Mr. Croll as to the causes of Glacial climate, and stated his agreement with them, except in one instance; he maintained, in opposition to Mr. Croll, that the glaciated hemisphere must be that in which the *summer* occurs *in aphelion* during the period of greatest eccentricity of the earth's orbit. He showed that a cool summer had more to do with the prevalence of glacial conditions than a cold winter, and referred to several phenomena furnishing arguments in favour of his opinion.

Discussion.—Prof. Ramsay remarked that Prof. Dana and himself had both referred the origin of many fjords to the same cause as the author.

GEOLOGICAL EXCURSION TO GUILDFORD.

Geologists' Association.—A geological excursion of the members and friends of this Society, accompanied by some of the students belonging to Prof. Morris's class at University College, took place on June 2nd, for the purpose of examining the geology and other natural features of the beautiful neighbourhood of Guildford. The excursion was under the superintendence of Prof. Morris, the President, who availed himself of the very valuable co-operation and guidance of Mr. C. J. A. Meÿer, formerly resident at Godalming, and long interested in the district, and whose published memoirs have largely assisted in elucidating its geology. At Guildford the party was met by Prof. Rupert Jones, from the Royal Military College, Sandhurst, accompanied by several friends and officers of the Royal Staff College. The chief object in view in this excursion was the examination of the several kinds of strata forming the hills and vales in the vicinity of Guildford, Shalford, and Chilworth, especially as to the relative positions of the several beds of chalk, clay, and sandstone, which, lying either horizontal or in more or less inclined positions (in some places turned up almost on end), come to the surface in succession, and form flat, raised, or hollow ground, according to their power of resisting the wear and tear of frost, rain, rivers, and other denuding agencies that have worked over the land during the countless ages looked back into by geologists.

Professor Morris occupied the attention of the party in one of the picturesque lanes near Shalford, by explaining the origin of the sandy soil they stood on, and the clay-beds to which the slope of the road was leading; how the sandstone, now turned up and exposed, was once horizontally laid down in the shallows of a wide sea, reaching from the raised land of the West of England far away into what is now Europe, and there deep, and richer in marine life, the waters deposited calcareous layers, now constituting the Neocomian formation of Neuchatel, represented in Surrey by a thin continuation, recognised as the Perna bed, as originally observed and explained by Mr. Godwin-Austen, of Chilworth, more than twenty years ago. Sands and mud filled up those primeval waters, leaving as the results the Lower Greensand beds, with their iron sandstones, white glass-sand (Reigate and Aylesford), Fuller's-earth beds (Nutfield), and Kentish Rag, where the oysters and other shells abounded more fully than elsewhere. Mr. Meÿer pointed out in the Shalford sands the few isolated shells representing the thick oyster-beds of the Kentish Rag, and indicated the exact horizon in the Surrey lane-cutting, where fossil lobsters are abundantly found in the so-called "Cracker beds" of the Lower Greensand of the Isle of Wight.

The very source of the pebbles and rolled bits of older fossils in these old sands of Surrey was indicated by the leaders to the students. Thus the Oolite beds of Mid-England were credited with the bits of rolled *Ammonites*, and the older Sandstones and Palæozoic rocks had to acknowledge the quartz-pebbles and fragments of lydian stone forming the grits and pebble-beds seen in the section of the Lower Greensand, in the ascent from the ford at East Shalford to the crest of Chilworth Hill, the many layers of the uplifted and denuded beds of which give rise to the picturesque escarpment.

On Chilworth Hill the party assembled among the rustic graves under the tower of St. Martha's Church, and there, backed by the North Downs, and looking out over the broad extent of undulating country at the distant South Downs, they listened to Prof. Rupert Jones explaining how the succession of hill and vale coincides with the harder and softer strata, of chalk, clays, and sandstones, brought up by grand but gentle curves, in orderly arrangement, around a long elliptic dome, reaching from Alton on the west to Hastings, and beyond the Straits to France, and worn down, by natural agencies, of long continuance, from a high broad ridge to the present comparatively low series of lesser ridges, and drained by rivers, following the radiating cracks of the raised ellipse, which have still kept their outward course through sandrock and chalk downs, deepening the widened rifts until the Pluvial period was over-passed, and now meander slowly among the gravel-beds and alluvial flats, till they reach the Thames on one side and the Channel on the other. On their way to Guildford the geologists visited, near Titlings, a pit of chalk-marl (used for plaster-lime), where the beds, upturned at an angle of 80°, afford a key to the general configuration of the country, as they show by local intensity the bending force to which all the *strata have* submitted. After some refreshment at Guildford, Mr.

Meÿer led the party to a quarry of the Lower Greensand west of Guildford, where the upper member of this interesting formation is well seen, with its oblique bedding and numerous regular faultings, and where its fragmentary shells, corals, and other organisms can be largely collected. A hasty visit to St. Catherine's Chapel, on the knoll of Lower Greensand, overlooking the railway, the valley, and Shalford Park, ended the expedition, which, favoured throughout with glorious sunshine, now broke up, amidst congratulations on a successful day and a happy meeting of mutual pleasure and instruction, with a hearty desire to meet again in that beautiful county under the guidance of the same good leaders.—*Mining Journal*, June 12, 1869.

CORRESPONDENCE.

DISCOVERY OF DIAMONDS, ETC., AT THE CAPE.[1]

SIR,—Having read in your May (1869) Number, p. 208, Dr. Atherstone's reply to my article (printed in the GEOL. MAG. Vol. V. p. 558, for December, 1868), entitled "Diamonds from the Cape of Good Hope," allow me to add a few words in rejoinder.

And, firstly, Dr. Atherstone says (p. 209), "As it was mainly through me that this accidental discovery was brought to light . . . I am therefore, by implication, accused of being one of the impostors in this fraudulent 'bubble scheme,'"—allow me to assure Dr. Atherstone that I did not intend in any way to implicate him, or indeed any one personally as acting designedly to mislead; my motive (whatever Dr. Atherstone or the Cape Newspaper Editors may insinuate to the contrary) was honestly to caution the scientific—and through them the public at large—against placing implicit reliance upon the newspaper reports sent home from that colony respecting these wonderful diamond discoveries, which, if not altogether without foundation in fact, were at that time, to say the least, grossly exaggerated statements.

Secondly, the same writer states (p. 213), "Mr. Gregory told me his object was not to search for diamonds but for Nickel and other minerals usually found associated with them," etc. I admit that I said I might look for Nickel minerals, but I deny most emphatically having said that I was going to search for *Nickel and other minerals associated with diamonds*, as Nickel ores are *never found* associated with diamonds. Indeed I am quite certain that not a single person in Cape Colony had any idea of the real object of my visit (whatever they may now assert to the contrary) until the appearance of Mr. Emanuel's letter in the "Journal of the Society of Arts" informed them, and subsequently my own article in your MAGAZINE already referred to. In matters of this kind I have learned to keep my own counsel.

Thirdly, as to my geological observations—(1) That with the knowledge we at present possess of the diamond-bearing rocks in other parts of the world, we are led from the geological character of that part of the country to consider it impossible that any diamonds could really have been found there: I must beg still to hold to that opinion—first, because Dr. Atherstone himself has no direct knowledge of the district referred to, nor, secondly, of the exact places where the diamonds were really found;[1] and, thirdly, because Dr. Atherstone told me himself that he did not know much about Geology, but that his son was a pupil of Professor Tennant's, and he was therefore interested in Geology. (2) As to my silence regarding the presence of *Dicynodon* remains: I was quite aware of their occurrence a few miles *south* of Cradock, and saw many specimens when at Dr. Grey's, of Cradock, but not any "*beautifully perfect* reptilian and other fossils" (*vide* p. 211), as stated by Dr. Atherstone; indeed these remains are always in a very fragmentary condition, by reason of the indurated and unworkable nature of the matrix in which they are contained. But *south* of Cradock does not mean—the whole district in a direct line from Cradock to Hopetown—which is what I stated in my paper (Geol. Mag. Vol. V. p. 558).

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[1] This letter was sent for publication in the June Number, but we were compelled to postpone it, with other matter, from want of space.—EDIT.

It should always be borne in mind that Geology, like many other sciences, is not infallible, and that it is quite *possible* that diamonds may be found in rocks where past experience has taught us they never occur,[2] but still we find the maxim *experientia docet* usually holds good in diamond-prospecting as well as in that for gold.

Fourthly, Dr. Atherstone's statement (p. 212) that, from a sight of a "photograph and plaster-cast," which he showed me, I "at once pronounced an opinion as to its quality, declaring it to be a 'boart' diamond of very little value," needs correction. What I really said was that, from the multitude of striæ on the imperfect faces of the dodecahedron (the form of which I could distinguish), I was led to conclude that it was not of first-rate quality; as to *its value* I gave no opinion whatever.

I could have wished (did space permit) to call attention to many grossly incorrect statements which have been printed in the Cape newspapers, both as to the diamond discoveries and also in reference to myself; but the proverb says, "passion is ever the enemy of truth." Both diamond and gold manias have affected this Colony, although, happily, the gold-fever is to some extent allayed by the fact that the precious metal has not hitherto been found in paying quantities. With the past year's experience, it is now hardly necessary to say to investors, "at all great bargains *pause* awhile."

James R. Gregory.

15, Russell Street, Covent Garden, London, *May* 20th, 1869.

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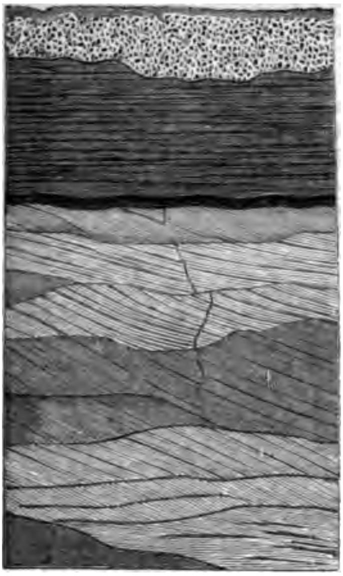
[1] All Dr. Atherstone's information (as may be seen by a reference to his article in the May Number, pp. 208–213), is obtained from the statements made by Dutch Boers, natives, farm-labourers, women, and children; and he does not appear in any single instance to have visited any reputed diamond region, so that at present we are no nearer than we were last year to the *actual locality* whence the diamonds announced were derived.—J.R.G.

[2] Mr. Sorby's recent paper, read before the Royal Society, suggests quite a new theory as to the formation of diamonds, and deserves careful attention; but little is known of the origin of diamonds or their parent rock, so that we must not entirely *put aside the old* theory for the new.—J.R.G.

ON A SECTION OF THE GAULT AND LOWER GREENSAND, AT LOWER FETTLEWORTH, SUSSEX.

SIR,—The papers by Mr. Judd on the Speeton Clay, and the Rev. T. Wiltshire on the Red Chalk of Hunstanton, which have recently appeared in the Quart. Journ. of the Geological Society, suggest my sending for publication the accompanying sketch of a section exposed in a cutting of the Petworth Railway, near Lower Fettleworth, Sussex, exhibiting the occurrence of a blood-red bed in association with Gault, and probably on the horizon of the Red-rock of Hunstanton and Speeton.

The section, which is from forty to fifty feet deep, exhibits four well-marked subdivisions.



(A) A bed of ferruginous surface gravel, five or six feet thick.

(B) Gault about ten feet thick.

(C) (D) A very hard blood-red ferruginous conglomerate at the base of the Gault, maintaining a uniform thickness of about four inches, and resting on

(E) The Lower Greensand, thirty feet of which is exposed in the cutting. The colour of the Lower Greensand varies from buff to orange; its upper part, (D), immediately under the band (C) being stained to the depth of a few inches of a bright blood-red.

The peculiar clear red of anhydrous sesquioxide of iron is rare in the British Cretaceous rocks, and notably distinct from the yellow and orange tints pervading the Lower Greensand. The red band C, like the red rock at Hunstanton, abounds in small quartz pebbles, held together by the ferruginous matrix.

Is it possible that it may be the southern extension of the red rock of Hunstanton and Speeton, expanded to six or seven feet thick at Hunstanton, and further north to thirty feet at Speeton? The Gault does not seem to have any certain representative in the north. The position of the Fettleworth red bed at the top of the Lower Greensand agrees with that assigned by Mr. Wiltshire for the Hunstanton red-rock overlying the "Carstone," and is not inconsistent with the horizon suggested by Mr. Judd for the Red Chalk, south of Speeton, resting unconformably on beds supposed to be the equivalent of the Upper Neocomian.

The intercalation of a thin red band, largely composed of anhydrous sesquioxide of iron, between beds of such different physical character, is difficult of explanation. The line of demarcation is remarkably definite, no gradation existing between the red stratum and the Gault above or the Lower Greensand below.—GEO. MAW.

BENTHALL HALL, BROSELY, *May 28th*, 1869.

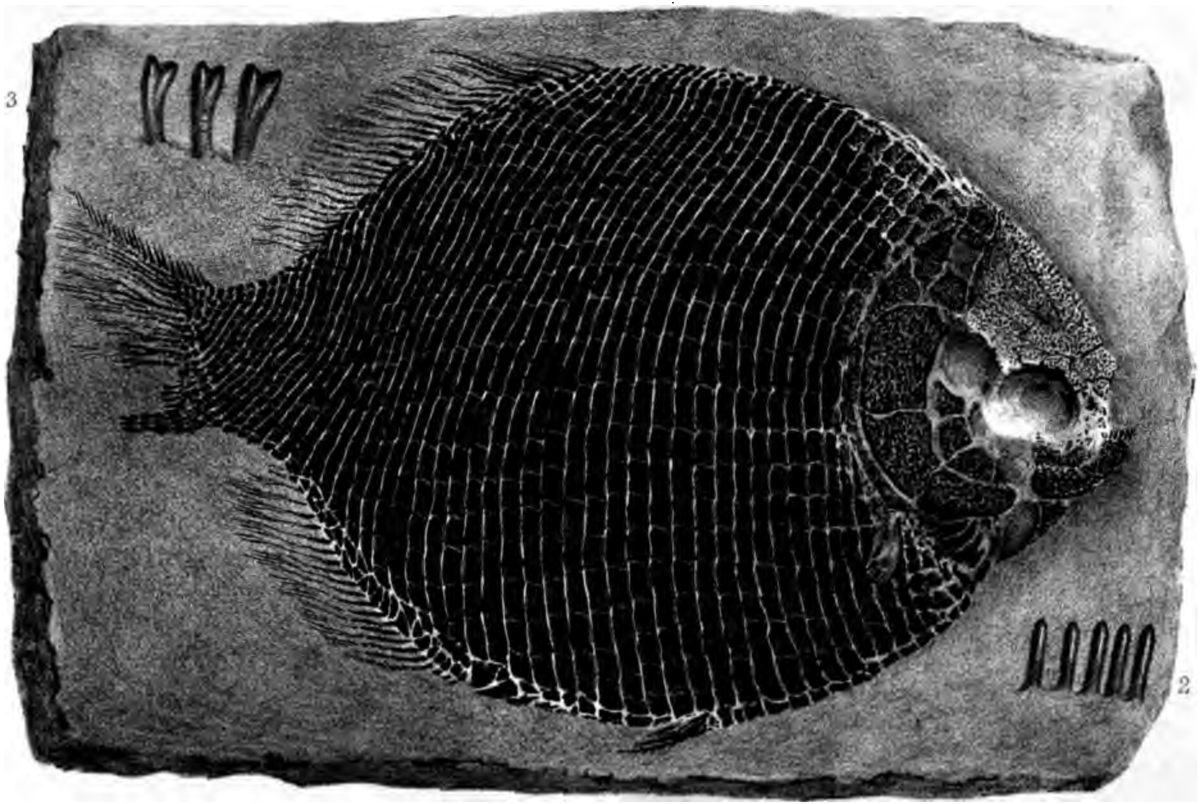
SINGULAR SUBSIDENCE AT MARTON.

SIR,—In reply to Mr. J. W. Wilson's description of a singular subsidence at Marton, near Northwich, perhaps I may be allowed to remark that the phenomenon is not so rare as may be imagined. When living in Cheshire I frequently heard of similar subsidences taking place. These occurred in every instance on the Keuper formation, and I attributed them to the dissolving away of a good portion of the rock salt, which frequently attains a thickness of nearly a hundred feet, by the percolation of running water. Considering the vast quantity of solid salt held in solution by the brine springs, this can hardly be wondered at. I do not think, however, that the subsidence of the surface usually takes place so suddenly. As a rule it will be in the ratio of the dissolution of the underlying rock-salt beds. It has frequently struck me that some of the small "Meres" in Cheshire have originated under similar circumstances. In Norfolk we frequently have subsidences of the surface by the dissolution of chalk by sand-pipes. In many parts of Lancashire and Staffordshire the surface of the country sinks where mining operations are carried on. This is best told by the great depth of the neighbouring canals, whose banks have had to be built up in order to preserve the level of the water. Near Dukinfield, the canal is in many places over twelve feet deep—the depth being a good index to the amount of subsidence undergone in consequence of the coal having been worked underneath. Newspaper paragraphs relating the sudden sinking of small areas are not rare in Norfolk, the usual vulgar explanation of them being of course earthquake action. Rock salt is much more readily soluble than Chalk, so that it is very probable the subsidences in Cheshire and Norfolk are due to the similar action of water in dissolving and removing the solid matter of the strata beneath. J. E. TAYLOR.

NORWICH, *June* 13, 1869.

MISCELLANEOUS.

A GIGANTIC OOLITIC LIZARD.—Prof. Phillips has lately recorded the discovery—in a quarry at Enslow Bridge, a few miles north of Oxford—of the femur of a monstrous lizard of the Oolitic age, measuring five feet and a third (sixty-four inches) in length, and 44·25 inches round the distal extremity; while the breadth at the upper end (taken obliquely) is 20·75 inches, and the circumference 46·0 inches. A similar bone (but not nearly so large) in the Oxford Museum was referred by the late Hugh E. Strickland to Prof. Owen's genus *Cetiosaurus*, to which genius no doubt this gigantic femoral belonged.



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THE
GEOLOGICAL MAGAZINE.

No. LXII.—AUGUST, 1869.

ORIGINAL ARTICLES:

I. GEMS FROM PRIVATE COLLECTIONS, No. 2.

On the Genus *Æchmodus* from the Lias of Lyme Regis, Dorsetshire.

By Prof. Morris, F.G.S., etc., etc.

(PLATE X.)

AMONG the many fossil remains of fishes obtained from the rich Liassic deposits near Lyme Regis, species of the genera *Dapedius*, *Æchmodus*, *Semionotus*, and *Pholidophorus* are most frequently found in a good state of preservation. These Lepidoid genera are chiefly Liassic, two of the more long-bodied forms, *Pholidophorus* and *Semionotus*, having species which occur in the Purbeck (*Phol. ornatus*) and the Chalk strata (*Sem. Bergeri*). *Lepidotus*, another Lepidoid, ranges from the Lias through the intermediate Oolite and Wealden strata into the Chalk, and according to Sir P. Egerton, "the genus *Lepidotus* has the most extensive geographical range of any genus of fossil fish." With the exception of *Lepidotus*, Prof. Owen[1] classes the above genera under the Dapedoid family of the order *Lepidoganoidei*, the genus *Dapedius* (*D. politus*) first noticed by the late Sir H. de la Beche[2] forming the type of the family. All the genera were arranged by Sir P. Egerton under the Lepidoid family of the order *Ganoidei*, and Mons. Pictet[3] placed them in his second family of Rhombiferous Ganoids—the *Lepidosteidæ*, and under the second tribe of that family—the homocercal *Lepidosteidæ* (*Lepidoides Homocerques*, Ag.), which he further subdivided into sections, some of which included the above-mentioned genera—viz.,

Species having an elongated body, a short dorsal fin, fulcra in a single row, dorsal chord persistent and protected by half-vertebræ ("halb-wirbel," Heckel.)—*Semionotus*, *Pholidophorus*.

Species having the body elevated and compressed, a single dorsal fin, *one row* of fulcra, a persistent dorsal chord protected by partially ossified vertebræ—*Tetragonolepis*, *Dapedius*, *Amblyurus*.

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[1] Palæontology, 1861, 2nd Edit., p. 166.

[2] Geol. Trans., 2nd Series, Vol. i. pl. 6, fig. 1–4.

[3] Traité de Paléontologie, 2nd Edit., 1854, Vol. ii., p. 157.

Species with a short dorsal fin, *two rows* of fulcra on all the fins, [vertebral column completely ossified and terminated as in all the homocercal Ganoids[1]]—*Lepidotus.*

According to Prof. Huxley, in a note to his valuable Memoir, On the Classification of the Devonian Fishes,[2] the above genera belong to the second sub-order, *Lepidosteidæ* of the Ganoid fishes, and to the family *Lepidotini*, which he distinguishes from the first sub-order *Lepidosteini*, in having—the maxilla in one piece, branchiostegous rays many and enamelled, the anterior ones taking the form of broad plates, and he classes together as one of the sub-families, *Æchmodus, Tetragonolepis, Dapedius, Lepidotus*, etc.

The genus *Tetragonolepis*, Bronn., formerly arranged with *Dapedius* and *Amblyurus* (and which also included a large number of species now classed under *Æchmodus*), has been shown by Sir P. Egerton to be a "Pycnodont" closely related by its dentition to the genus *Microdon*, and having the scales differently arranged and articulated; instead of the interlocking pegs and notches by which the scales of *Amblypterus* and allied genera are joined, "each scale bears upon its inner anterior margin a thick solid bony rib, extending upwards beyond the margin of the scale, and sliced off obliquely above and below, on opposite sides, for forming splices with the corresponding processes of the adjoining scales."[3]

The genus *Æchmodus* was instituted in 1854[4] to include several species formerly arranged under *Tetragonolepis* by Agassiz, but which were found by Sir Philip Egerton to present certain distinct characters. These are *Æchmodus* (*Tetragonolepis*, Ag.) *angulifer, confluens, dorsalis, heteroderma, Leachii, leiosomus, ovalis, pholidotus, pustulatus, radiatus, speciosus, mastodonteus.* Thus dismembered, *Tetragonolepis* contains but one British species, *T. discus.* Eg., for the *T. monilifer* and *striolatus* are now referred to *Dapedius* and *T. mastodonteus*, (Ag. 2, p. 216 to 23*e*., f. 3–5), is probably a *Lepidotus.*

The main difference which exists between *Æchmodus* and *Dapedius* consists in the character of the teeth, the former being unicuspid, the latter bicuspid, as shewn in Figs. 2 and 3, Plate X.

The specimen figured (Plate X.) presents the following characters: Body short, orbicular, compressed; length from the opercular plate to the commencement of the caudal fin exactly equal to the breadth of the flank from the ventral to the commencement of the dorsal fin. Scales twice as broad as long, and rectangular as far as the middle of the large opercular plate, gradually becoming smaller towards and near the dorsal line; scales smooth and more or less crenated posteriorly. (The line of lateral scales perforated by the mucous canal, although not distinctly marked in the specimen figured in the plate, is more clearly seen in some of the specimens in the British Museum.) The nuchal scales are marked by elongated tubercles which decrease in size and number, and finally disappear before reaching the dorsal fin. The pedicle scales are longer than broad and rhomboidal; dorsal fin nearly half the length of the body, commencing nearly opposite the ventral fins, and ending near the pedicle of the tail, the rays, about thirty in number, diminishing in size posteriorly; pectoral fins very small (about twelve rays), ventral (six or seven rays) small, placed midway between the pectoral and commencement of the anal fin, which is nearly one-third the length of body, and has about twenty rays, and is continued nearly to the caudal fin. Caudal fin moderately large, squarish, rays about twenty-four in number, which bifurcate at a short distance from their origin, and are further subdivided, the upper and lower rays with fulcra, in a single series.

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[1] Among the many examples of Fossil Fishes belonging to this genus which are preserved in the National Museum, Mr. W. Davies (to whom I am exceedingly indebted for much valuable assistance in drawing up this paper, and whose knowledge of Fossil Ichthyology is very extensive) assures me that no trace of a decided bony column exists in any well authenticated species of *Lepidotus* with the exception of *Lepidotus serrulatus* from the Lias of Barrow, and *L. fimbriatus* from Lyme Regis, both of which species, from other peculiarities, may eventually be found to form a sub-genus. I am therefore led to conclude that the complete ossification of the notochord is not a characteristic point in *Lepidotus*, as stated by M. Pictet. Prof. Pictet says, *op. cit.* p. 161, Le *Lepidotus fimbriatus*, Ag. est une espèce dont la position générique est encore douteuse. Les écailles ont une fine dentelure sur leur bord. Le *L. serrulatus*, Ag. a des rapports avec le *L. gigas*, mais en diffère, ainsi que de presque tous ses congénères, par ses écailles qui sont plus étroites vers le bord ventral.

[2] Mem. Geol. Survey, 1861. Decade x. p. 28.

[3] Quart. Journ. Geol. Soc., Vol. ix. p. 276.

[4] Egerton, Quart. Journ. Geol. Soc., 1854, Vol. x. p. 367.

General form of head sub-oval; the orbital, opercular and sub-opercular, and other plates are coarsely tuberculated. The tubercles being somewhat adpressed and more or less elongated. The branchiostegous rays five? on each side.

The length from the snout to the extremity of tail is about 8 inches, the height 4¾ inches; length of body from opercular plate to the commencement of tail 5 inches; length of head from the snout to posterior part of opercular bone 1¾ inches; depth of head 2½ inches.

The bones of the head are somewhat displaced and broken, the maxillary crushed and distorted, but the opercular, sub-opercular, and dentary bones, as also the branchiostegous rays are well shewn.

There are in the National Collection no fewer than six specimens of this Liassic fish agreeing closely both in size and proportions, and quite as well preserved as the specimen figured in our Plate.

It is interesting, too, to notice that whereas the other species of *Æchmodus* and *Dapedius* are exceedingly variable in proportions—indicating several distinct species—the fish before us is well-marked and quite specifically distinct from any figured by Agassiz, or described by Sir P. Egerton.

The figure in the Poissons Fossiles, which most closely approaches it, is the *Æchmodus pholidotus* of Agassiz, from the well-known Lias locality of Boll, in Wurtemburg (see Poiss. Foss., pl. 23*e*, fig. ii.); but from this species it is distinguished by its more orbicular outline (resembling that of *Dapedius orbis*, Ag. Poiss. Foss. Tab. 25*d*) and by the length of the pedicle, the form of the tail and character of the scales, which are longer than in the specimen figured by Agassiz.

The *Æchmodi* are rather short sub-orbicular, compressed-bodied fishes, with rhomboidal scales, a single well-developed dorsal fin, partly opposed to the anal, the pectoral and ventrals being small, and the fin-fulcra in a single series. They closely resemble *Tetragonolepis* and *Dapedius* in general form and character, but differ from the latter genus, as above noticed, in having the anterior teeth conical and single pointed, instead of being notched or bifurcate; from the former they are distinguished by the dentition and mode of articulation of the scales.

On the discrimination, however, of a genus of fishes by the form of the teeth, Sir P. Egerton remarks:—

"But, alas for the constancy of fishes' teeth! a specimen came into my hands not long ago having a combination of the two forms of tooth, the principal sets in each jaw being conical and single-pointed, and all the subsidiary teeth bifurcate. Having had my attention thus directed to this point, I have since found a specimen of *Dapedius punctatus* in Lord Enniskillen's collection, which has both forms of tooth in the principal series in both jaws. The conclusion, therefore, is irresistible, that the form of tooth is a character too capricious to be relied upon in this instance as a generic definition."[1]

The species of *Æchmodus* are chiefly from the Liassic deposits of Europe, and one has been recognized from the Oolitic beds of the Deccan, the *Dapedius Egertoni*, Sykes (*Æchmodus*, Egerton).[2]

It has been considered useful to figure this species of *Æchmodus*, not only as illustrating the genus which has not heretofore been figured in any English work, with the exception of a restored outline of the genus in "Lyell's Elements of Geology," p. 418, but also as shewing a type of ganoid fish of the Mesozoic period having the tail nearly symmetrical (homocercal)—a character by which the majority of the Secondary ganoids are distinguished from the so-termed heterocercal[3] ganoid fishes of the Palæozoic period.

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[1] Quart. Journ. Geol. Soc., Vol. ix. p. 275.

[2] Ibid. p. 352.

[3] With regard to these terms, see the remarks by Prof. Huxley, Quart. Journ. Mic. Science, Oct. 1858, and Mem. Geol. Survey, Decade x. to p. 3, where he states "that the so-called 'homocercal' *Teleostei* of the present epoch are in reality excessively heterocercal; but the word 'homocercal' is now so generally understood to signify a tail like that of most existing *Teleostei*, that I prefer to employ Prof. M'Coy's term 'diphycercal' for truly homocercal tails."

In alluding to these structures, Prof. Owen writes:—"The shape of the caudal fin varies much in fishes, according to the kind and degree of motion required: in the imprisoned embryo, in the long and slender undulating eel, in the sluggish Lepidosiren, the vertebræ continue to the end of the body in a straight line, distinct and decreasing to a point; and the tail is bordered above and below by a vertical fold of skin; terminating either in a point or obtusely. Such fold or fin is symmetrical, but not 'homocercal.' The vertical folds deepen; at first equally, forming a terminal lobe; then excessively, in the lower or hæmal fold, with the developement therein of rays, and with an upward or neural inclination of the supporting vertebræ. Shorter rays are developed in the shallower neural fold, which terminates at the pointed end of the vertebral series. The anterior rays of the hæmal fold, which are the longest, form a second point. The tail is thus bifurcate, but unsymmetrical; and this stage of the developement is termed the 'heterocercal' one. It was the fashion of tail which prevailed in fishes throughout the palæozoic and triassic periods. In some oolitic fishes, first is observed such a *lengthening* of the dermoneurals of the tail, with such a shortening and run-

I beg to propose for this fish the trivial name of *orbicularis*.

I am indebted for this specimen to the kindness of W. H. Huddlestone, Esq., F.G.S., who obtained it during a late geological excursion to Lyme Regis.

EXPLANATION OF PLATE X.

Fig. 1. *Æchmodus orbicularis*, Morris, from the Lower Lias, Lyme Regis, Dorset. Original specimen in the collection of the author (two-thirds nat. size).
Fig. 2. Teeth of *Æchmodus* (magnified three times nat. size).
Fig. 3. Teeth of *Dapedius* (magnified three times nat. size).
Figs. 2 and 3. Drawn from specimens in the British Museum.

II.—On Faults in Strata.

By Henry B. Medlicott, B.A., Geological Survey of India.

A LITTLE time back there appeared in the Magazine, some short papers on the subject of faults,[1] and on the nature of the conditions and the forces through which these important structural features may have been produced. The points I would now bring to notice are more elementary; they refer to the evidence for faults; hence involving the principal data upon which the higher discussion of the phenomena must be based, and the same data very largely affect our attempted restoration and history of bygone phases of the earth's surface. Faults and flexures in stratified rocks are the leading features through which we interpret the disturbances that have affected the earth's crust; and any looseness in determining their existence, form and amount, must vitiate many of our inferences. No one but an experimental field geologist can appreciate the difficulty of such determinations, and understand how faults are particularly liable to elude observation. This circumstance accounts for, but does not justify, the arbitrary use of faults in interpreting sections. To call in question the evidenee upon such a familiar subject implies, of course, dissatisfaction at the manner in which it is handled in practice. This I at once admit, and will proceed to explain. The criticism I have to make is no more than might occur to one who had never left his study; but I would state that with me it has had a most practical origin: in the progress of the work of the Geological Survey of India, several great boundary faults have been proposed in connection with our main rock-series, and in some cases published descriptions have been already given; but both on the score of the insufficiency of the evidence brought forward, and after personal examination in the field, I am unable to admit that some of the features in question can, without very implicit qualifications, be brought within the received definitions of a fault. I believe that it

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ning together of the terminal vertebræ, and such a proportion of the dermohæmals, as leads to an equal-lobed caudal fin, which has been termed 'homocercal;' but as it is only symmetrical in contour, and remains more or less unsymmetrical in its framework, I term it 'homocercoid.' The ganoid fishes of the mesozoic periods manifest several interesting gradations of this transitional state from the hetero- to the true homo-cercal form, each step being a permanent character of the extinct species presenting it.—Comparative Anatomy and Physiology of Vertebrates, 1866, Vol. i., p. 253.

[1] See Geol. Mag. 1868, Vol. V., pp. 205, 339, 341, etc.

is quite misrepresenting the said features to describe them simply as fault-boundaries. It would be comparatively useless, in an attempt to ventilate this question, to illustrate it exclusively from sections in India; but it may, perhaps, be presumed that professional practice in this country is not very far behind the age, and that it will be easy to find illustrations within the reach of the centres of scientific research. I cannot make a better selection for this purpose than the highly authoritative work lately brought out by Professor A. C. Ramsay, on the Geology of North Wales.

The definition of a fault is as cut and dry as could be desired; a verbal completeness that may, in this case, as in so many others, have helped to the neglect of the thing itself. It is a fissure along which relative displacement of the adjoining rock-masses has taken place. Although considerable latitude must be allowed in the application of the term, from the clear-cut fissure, with throw, to what is merely an overstrained contortion, geologists have unanimously given up the miner's purely technical use of the word, and have made transverse dislocation the characteristic of a fault. I would limit the *direct* evidence for such a phenomenon to the fissure itself, with what signs it may have of the supposed mechanical action, such as friction-surfaces. As regards 'fault-rock,' it would be difficult to define the composition or structure of a rock that would necessarily imply faulting: veins often become filled in the most heterogeneous manner with the debris of their walls, and thus a breccia of any form may result. It is conceded, too, that the evidence of friction-surfaces may be slight, or even superficially deceptive: a very small movement, that would hardly deserve notice on a geological map, as a fault, might cause much scoring of the opposed surfaces: or, it might often happen in a fault that the friction would be localised at the projecting parts of the surfaces, having large patches without any trace of such action. Still, this direct instance should be sought for. When it is considered what safe and important records of this kind have been left by glacial action, it is surely to be expected that great section-surfaces of the earth's crust passing against each other for several thousands of feet, under the forces that must be engaged in the production of such amounts of motion, should leave some traces proportionate to the action. But it is precisely on these points that I would ask for information, to be delivered from the uncertain, because misplaced, use of *à priori* resources. It would be a great aid to the observer, if it were established that the absence of any evidence of friction in a fissure, or plane of contact of dissimilar rocks, gave presumptive proof against much faulting. Should it on the other hand be proved from independent evidence, that great faults have occurred without leaving any direct traces, the fact will at least suggest important inferences upon the nature of the phenomenon; such as, that the vertical motion cannot have occurred simultaneously with great lateral pressure. I will presently indicate the important evidence on the other side that may be expected from the examination of the actual contact of rock-masses in juxtaposition, and which would independently justify the demand for the production of this direct evidence in the case of asserted boundary-faults, the indirect evidence being in these cases always more or less inconclusive.

The *indirect* evidence for faults is the transverse separation of rock-masses that were originally continuous or contiguous. For those who can accept the proofs of such former conditions, this evidence is perfectly demonstrative; and it gives the only means of calculating the amount of the throw. It may be said that the fault is, after all, wholly dependent upon that prior and distinct question—whether the rocks in contact were, or were not, originally so (*i.e.* from the time of formation of the younger); for, as has been observed, the direct evidence may give no certain answer upon the amount of the throw, which may be so slight as to be unworthy of notice unless in some very special inquiry, where it would only rank as a simple fissure.

In determining the existence, position, and amount of an unseen fault in stratified rocks, great attention has to be directed to the dips and strike of the strata. I would thus partially account for an error that seems to have gained credit with many field geologists, that the existence of a fault can be detected from a one-sided examination of the dips—from the arrangement of the strata on one side of the supposed fault. The question is a vital one, for it obviously comes most frequently into operation in important cases of apparently great "master-faults," where later sedimentary rocks are in juxta-position with crystalline, or widely distinct masses. The origin of such a notion is, perhaps, traceable to the "fixed idea" of the fundamental principle of Geology,—the *super*-position of the younger deposits. However this may be, it would seem to be a rule with many observers at once to set down as a fault any abrupt, steeply inclined, junction of rocks of different ages, and showing signs of disturbance. A reference to any actual area of the earth's surface would, in the first place, remind one that in any basin of deposition new strata must often abut against steep surfaces of the old supporting rock. And upon the second point (that of disturbance), a brief consideration would satisfy one that a subsequent lateral compression, modified by slightly varying conditions of resistance, might produce any imaginable complexity of dips in the younger strata near such contact.

There is another point in connection with faults upon which our preconceptions are allowed to interfere with true observation. From the manner in which we sometimes see the faults of a district forced into "systems," according to the direction they run in, one might suppose that the only chance of explaining them depended upon this being done; or, that the observer's work were accomplished, and a scientific result attained, by the production of anything that can be called a *system*. These systems are, indeed, sometimes seen to be self-destructive where they manage, more or less, to lose the compass between their limits, but the mere attempt is to a great extent based upon a *petitio principii;* to cause such symmetry of arrangement, it is assumed that in the production of faults, such widespread and deep-seated forces are altogether dominant. It is, indeed, an open question to what extent such is, or has been, in remote times, the case: and, therefore, one should look out for any marked coincidences in direction, being careful at the same time to remember that denudation and redeposition are apt to follow ancient main lines of flexure. But it is also evident that faults may be determined by circumstances that would put general symmetry of direction out of the question,—by differences in thickness, in texture, in position with reference to more resisting masses, of the strata acted upon. There are, besides, the manifold marks of origin of the movement, whether from simple compression, or compression with subsidence, or with elevation. Amid such complexity of causes, active and passive, it is manifestly Procrustean to force the faults of a district indiscriminately into unmeaning "systems," as is sometimes done, to the neglect and confounding of more direct and important conclusions.

Two examples will illustrate part of what has been set forth. In north-east Bengal, sandstones of the Cretaceous period are found rolling up to the south base of the Garo Hills, where they are at last seen dipping at very high angles (over 80°) from, and in immediate proximity to, the gneiss that forms the high plateau—a mode of relation highly suggestive, some would presume, of a fault. In this case, moreover, the required indirect evidence is partially, indeed I may say fully, present; at some few miles distance, at an elevation of 4,000 feet on the plateau, Cretaceous sandstone of the same horizon rests undisturbed: there being no doubt of the two having been originally continuous. Great, and more or less abrupt, relative movement must be accounted for. A reference to the direct evidence fully satisfied me that there was no master-fault: by hunting up the boundary an actual contact was found showing the plane of junction with the gneiss to coincide with the dip of the sandstones, and the bottom bed of the latter to be conglomeritic, containing large waterworn debris of the gneiss. There was no sign whatever of friction or of local crushing. It was evident that the existing arrangement had been effected by some mode of flexure or of yielding, within the mountain mass, whereby the Cretaceous surface of deposition had been brought near to the vertical. It is difficult to suppose such an amount of movement taking place within a mass of rocks without some fissuring and sliding (faulting); but hardly any amount of such secondary effects would, to my mind, justify the representing such a feature as a fault-boundary. It may be well to add that the mistake I now combat has not been made; I believe I am the only geologist who has seen this Garo Hill section.

Again, in the low jungly hills at the base of the north-west Himalaya, there is a very continuous and well-marked boundary between two groups of the sub-Himalayan series. The younger deposits very generally dip towards the older at high or low angles, apparently going into or under them; both are very partially indurated, and the confusion and crushing near the contact is considerable. Here, again, one might suppose a plain case of faulting. It is true there is no certainty that the younger strata had ever stretched beyond their present boundary; but this negative difficulty would be readily disposed of by denudation. The demand for the direct evidence saved the case from total and fatal misrepresentation; within a length of 200 miles one section of the contact was found, and it showed the younger strata abutting into and against a serrated, weathered surface of the older; the supposition of faulting being thus inadmissable.

These two cases differ in every particular; but they teach the same lessons—that dips by themselves give no presumption whatever in favour of a fault; and that the direct evidence of the actual contact, if it can give but poor evidence for a fault, may, on the other hand, give the most positive evidence against a fault.

It is not unlikely that by a proper search I should find I have been saying what has been better said before now; and that much of the information I require is already accessible. The opportunity for such an enquiry is not, however, available to me at present; and it is, in any case, abundantly evident that the remarks need to be brought forward. In the work I have already referred to, faults are mentioned on almost every page; their vertical throw ranges from 11,000 feet downwards; they would rank among the most remarkable structural features of the country. Any one who may wish to be reminded of the important function performed by faults in geology, need only to examine the beautifully drawn sections appended to that volume: the dotted lines above the surface are not drawn merely to indicate the equivalents of distant outcrops, but to represent the amount of matter that has been removed by denudation. The approximate accuracy of this interpretation depends to a great extent upon the evidence for these faults, more especially of those great boundary faults the indirect proofs for which can seldom attain the same certainty as in the case of faults within the limits of one series of strata. Yet in only one instance in this work could I find specific notice taken of the direct evidence, and that only incidentally and in a less important case, where (p. 143) it is said that the marked occurrence of *slickensides* seems to indicate a fault. There are some instances given of faults coinciding with veins or dykes; but veins and dykes, without any attendant faulting, are of common occurrence. There are also cases given of the fissure and the displacement along it being exhibited in the face of cliffs; but even this is not explicit enough. Of the independent use of the indirect method excellent examples are given on p. 88, in accounting for the reappearance of the Bala limestone in stepped outcrops.

Of the illegitimate evidence from dips, numerous instances occur: thus on p. 59, it is said "The evidence of the fault is perfect, since both formations yield a sufficiency of dips, and are run to strike directly at each other." Again on p. 191, "The fault on the south is certain, black shales and their grits being on the coast visibly thrown against the altered strata." A similar argument is used on p. 169. But it is where the rocks in contact are most widely distinct, that the highly unsatisfactory nature of such evidence becomes fully apparent, as on p. 198, the Carboniferous Limestone is said to "dip against the metamorphic foliated schists at a high angle, clearly indicating a fault." Now to the case of these strips of younger rocks in Anglesea, such evidence seems more than inadmissible, for the deposits are described as variable, coarse, and beach-like, full of the debris of the adjoining rocks—facts, highly suggestive of their having been formed against cliffs of these rocks; but all this is unnoticed in favour of a 'plane of marine denudation' and faulting; no allusions ever being made to the information, or no information, derivable from the examination of the contact, or to the possibility of any other mode of interpretation. Even among the older rocks, the original features of the strata, as described by Professor Ramsay, are similarly suggestive: within so small an area, there are prodigious changes of thickness and of composition in almost every group, facts suggestive of great inequalities of level almost to the extent of partially detached basins of deposition; all which circumstances might greatly modify the view put forward of the section, and radically damage the presumptive and very indirect evidence given for some of the great faults. All these features may exist as described, and the high reputation of the author insures their acceptance in full faith. I would only remark that the impartial reader is left unconvinced, because of the unsatisfactory nature of much of the evidence given, and the omission of evidence that cannot be dispensed with.[1]

If such great lines of movement are not fissures and loci (at least potentially) of friction, they are not faults, according to the accepted definition, and some term should be adopted to distinguish them from simple faults. Some such apparent cases that I know of in India are, I believe, nothing more than very steep limits of original deposition, against which the younger deposits very rapidly overlapped older groups of the same series: subsequent settlement of the deposits, with some lateral crushing, and accompanied by more or less of very local faulting, has completed the similitude of a great 'boundary fault.' The distinction, however, makes an enormous difference, for the simple announcement of a fault implies the former undiminished extension of the deposits. To represent such a boundary as a fault, on the strength of such small slips as may occur, brings forward a subordinate, secondary, and trivial circumstance, putting out of sight a most important, original, though now modified relation of the adjacent rock masses. So long as faults are used—though not avowedly or consciously, as a key to a Chinese puzzle might be used to make the pieces fit—the result may look very well, but it will leave us no wiser as to the natural history of the rocks.

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[1] Since writing as above, I have recollected and referred to a high authority upon the very features under notice. Professor Haughton in a paper in the Proceedings of the Geological Society of Dublin, vol. vi., 1854, describes the great Bangor and Carnarvon 'fault,' in a manner reconcilable with the view I have suggested, he says (p. 6) "The newer palæozoic beds dip towards the porphyry band, and appear to have been originally deposited quietly upon its western slope. Some cause or combination of causes—either alterations of relative level, or lateral pressure, or a combination of both—gave to these beds a slight dip towards the south-eastern side, and a line of strike making an angle of 20° with the porphyry band." I must note my surprise that Professor Haughton, although in his paper deprecating "vagueness and looseness of expression," seems to use the word fault, out of its proper geological sense, to mean a vein (p. 5.).

I may mention that the paper on some Alpine and Himalayan sections, which I had the honour to lay before the Geological Society two years ago,[1] bears upon the question here discussed: there is said to be a fissure along the base of the Alps, currently supposed to have swallowed up mountain ridges, and at sundry times to have given egress to the whole mass of the Alps; yet no one has given a circumstantial description of so wonderful a feature. If such a fissure can hide away and tell us nothing of such mighty performances, there will be, to my mind, a greater flaw in the geological record than any yet proved from palæontology.

III.—NOTE ON THE EXCAVATION OF THE VALLEYS IN DERBYSHIRE.

By H. C. SORBY, F.R.S., &c.

FOR a considerable time I have taken much interest in the question of the origin of the narrow and deep valleys in the Carboniferous Limestone district of Derbyshire, and have carefully recorded whatever seemed to explain their formation. So far I have never met with more striking facts than those to be seen in Deep Dale, about three miles in a direct line E.S.E. from Buxton. I estimate the depth of the valley at about 100 feet, and its width at from 100 to 200 yards. At a distance of about a mile from the Bakewell road there is a cavern, which is especially conspicuous on the east side. Its entrance is about 6 feet high, 20 feet broad, and 40 feet above the bottom of the valley. It extends nearly horizontally for about 30 yards, and then descends to a lower level, where I did not further examine it. On looking from the entrance to the opposite side of the dale I was surprised to see what appears to be a continuation of the same cavern. The entrance on that side is at about 80 feet above the valley, and is so much blocked up with detritus that one can only examine it for a space of 10 yards. Taking, however, all the facts into consideration, it appears to me that at a very remote period a subterranean stream flowed continuously along these two caverns, from west to east. There is abundance of suitable gather ground on the west side which even now has no well-marked surface drainage, and from which much of the water probably escapes by a subterranean course, ending in the large spring in the main valley, by the road-side below Kingsterndale. Of course the continuous passage of a stream through the two portions of the cavern could not possibly occur in the present state of Deep Dale—the water would have to run down one side of the valley, and up a steep incline on the other, and, therefore, I argue that at the time when the cavern was the bed of a subterranean stream, Deep Dale was only excavated to a slight extent. In the process of time, however, its depth was so increased that the cavern was cut in two; and a similar increase in the depth of the main valley of the Wye so altered the general drainage of the district, that water almost or entirely ceased to flow along the old channel. The point of chief interest is, therefore, this—that the facts lead us to believe that by far the greater part of such a valley as Deep Dale has been excavated since the surrounding country was dry land, probably chiefly by means of the same slow process of erosion as is now taking place, though the distribution of gravel brought from a distance indicates that this part of England has been again below the level of the sea at a comparatively recent period.

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[1] Read June 5th, 1867. Published in the Quart. Journ. Geol. Soc., London, 1868, Vol. xxiv., p. 34.

IV.—ADDITIONAL NOTES ON THE GROWTH OF SOIL.

By G. H. KINAHAN, M.R.I.A., etc.

IN the former notes[1] "On the growth of soil," I omitted to speak of the labours of the ants—these workers, although such pigmys in this country, and, therefore, compared with the earth-worms, less capable, individually, of work, are so numerous and energetic, that in the special places to which they resort, their yearly work is much more conspicuous than the annual worm-work; but the animals operate in different places, for while the earth-worm luxuriates in rich highly-cultivated land, the hill-building-ant loves a dry, sandy or peaty soil. In the spring the ants may be observed beginning their work, and from that time they carry on their operations all through the summer, to the late autumn, or early winter. On a moor they raise hillocks scattered promiscuously about over the ground, getting closer and closer together as the colonies increase. But where the ants are most useful is in places where crags and large stones are mixed up with patches of sandy peat. In such a locality they will always build on a rock, the foundation of their habitation being at its junction with the soil. These ants seldom raise their structures as high as the moorland ants, but they make up in extent for absence in height, and by this means the rocks are gradually covered with soil and vegetation; for, on account of the season of the year at which they build, the growth of the plants keeps pace with the formation of the ant-soil, and protects it in a great measure from "Meteoric abrasion."[2] During the winter, however, the shape of the ant-hills is somewhat modified, but the matted roots of the plants preserve the major part of the soil which will thus remain, forming an envelope for the rock.

As the annual work of one colony is rarely less than two square feet in superficial area, and sometimes exceeds a square yard, the yearly work done by a number of colonies must be very considerable. The ants that build in the sandy moors seem to frequent the same spot year after year, and some of the hillocks after a number of years are of a considerable height, some that were measured in the county Cork being four feet high and nearly a yard in diameter at the base. But the ants that build on rocks in general appear yearly to occupy new places, but, perhaps, not always, as it has been remarked in a few instances that the new work was carried on in a place where other works had been in progress the previous year; but whether it was the same colony that worked the two successive years I am unable to say. The rock-covering ants are undoubtedly the more useful animal, but the others have also a serviceable place in nature, as they change a cold unprofitable peat into a good vegetable soil.

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[1] GEOLOGICAL MAG., June, 1869, page 260.

[2] When I proposed *chemico-fluvial denudation* as a better name than the vague term *sub-aërial denudation*, I had quite forgotten that Mr. Scrope some time since, called the same action *Meteoric abrasion.*—[*Geology and Extinct Volcanoes of Central France.*] This name is evidently so much superior to any since proposed, that I am surprised it has not been universally adopted.

A fact in favour of vegetable decay as a soil-producer, and apparently against worm-work, which was not alluded to in my previous paper, may now be mentioned. The greatest enemy a gardener can have to his grass-plots is the earth-worm, for, if allowed to live in them, their appearance will be spoiled. To prevent worms frequenting the place, previous to sowing the grass-seed or sodding the plots, the gardener will place a layer of charcoal under the surface soil or the sods, according to whichever plan he is following. The charcoal, although it is a great preventive, will not quite eradicate the worms, therefore after each cutting of the grass all worm-holes must be carefully searched out, and a weak infusion of mustard and water, or a decoction of *Tussilago farfara* ("Coltsfoot") poured down each, which drives the worms to the surface, when they can be picked off, and thus eventually they are all eradicated. After the worms are all destroyed, if they were the only soil-producers, the surface should not increase; yet that it does is evident from the growth up the pedestal of flower vases, and on the edges of the walks and flower beds. It must be admitted, however, that the increase is very small, the vegetable decay being at a minimum, by reason of the constant, artificial, removal of the grass-crop.

A remarkable instance of the growth of soil was observed in the Moycullen hills, the south-east group of mountains in Yar-Connaught, Co. Galway, Ireland; at a lake called Slieveaneena Lough. This lake lies on the north and south water-shed between the river-basins of the Corrib and Boliska [*anglice*, The Black water], and has two outlets, one leading respectively into each of the rivers just mentioned.[1] Formerly this lake, during low water, only flowed into the Corrib river-basin, the eastern margin being naturally lower than the western. The former, however, was composed of drift, while the latter was a bare granite rock; therefore on account of the small quantity of water flowing from the lake during the dry months of the year, and the moist nature of the climate, bog grew on the drift, while it could not on the granite, and eventually the eastern bank out-topped the western, so that now during low water there is a westward stream, and only during the winter months can the water flow east as well as west.[2] Lough Slieveaneena occupies about twelve acres, has a small water table on the north and south, and lies in a rock basin, that bears east and west. The eastern margin of this rock-basin, previous to the drift being deposited on it, was much lower than the western, and even afterward all the water would have flowed to the Corrib, had not the growth of the soil formed a barrier.

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[1] Memoirs Geol. Survey of Ireland, Explanation of sheet 105, p, 6.

[2] At the present time there is an artificial drain cut towards the east through the

Mr. John Edward Lee, F.S.A., F.G.S., the translator of Dr. Keller's "Lake Dwellings of Switzerland," in a note on the depth of soil covering the "Mainland Settlement of Ebersberg," records a remarkable growth of soil at Caerleon, South Wales. Mr. Lee thus writes: "In a field which forms the south-west portion of the ancient city of Isca Silurum, I have frequently excavated for the sake of archæology, and in one instance, when the summer was dry, the grass showed where walls were probably to be found, indicating the ancient Roman houses forming the corner of the inhabited portion, an open space of the street being between them and the city walls. It was, however, very singular that these indications, though correct, were not verified till the ground had been excavated to a depth of five or six feet; and before the actual base of the wall and the floor of the street were reached, a tall labourer was entirely hidden from view. The first foot or two may be accounted for by the rubbish when the place was destroyed, but as no soil is likely here to have been brought down by floods, we are almost obliged to attribute the remaining four or five feet to the annual addition of vegetable mould. The excavation above referred to, is not the only fact which indicates a great accumulation of soil; a handsome tesselated pavement lately discovered in the churchyard was four or five feet below the present surface, etc., etc."[1] This is a startling fact in favour of the growth of soil, by vegetable decay; and Mr. Lee further states, in a subsequent communication on the subject: "The old town of Isca is on a tongue of land slightly above the flats on the rivers' banks (the Usk and the Avon Llwydd), and from the situation there is no chance whatever of any earth being brought down from the hills to the place I mentioned." Although apparently so large in the aggregate, yet, when the yearly amount is calculated, it seems not so large. It must be about 1700 years since the Romans occupied the site, and if two feet are allowed for the depth of the debris of the building, there will be four feet to be formed by the growth of the soil: this is equal to 2·82 inches in a century, or ·028 inch annual growth; scarcely equal to the thickness of five sheets of foolscap paper,—or, another way to explain it, one inch growth in every 34·6 years. Furthermore, all may not be due to the vegetable decay; for, as the field is near Caerleon, it is

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bog. When the lake was first visited in the early summer this drain had just been opened, about five feet deep, to make up the fences, and although it did not reach to the bottom of the peat, yet it was lower than the western *embouchure*, and carried off all the summer water. At a subsequent visit, nearly two years afterwards, the eastern cut was choked up by aquatic plants, among and behind which a peaty sediment had been deposited, and thereby formed a dam, which drove the summer water to flow westward, to the Boliska.

[1] *Keller's* Lake Dwellings, p. 367 *footnote*.

probable that it has often been "top dressed," a process which would quickly add to the depth of the soil. It should, however, be mentioned, that some years since, a field, in the north part of the county Tipperary, was broken up, that had a soil fourteen inches deep, and this field a man, seventy years old, knew to be exactly 110 years in grass. As the average depth of soil, in this part of that county, is from ten to twelve inches in depth, it would leave about 2·5 inches of soil to grow in the century, which is very similar to the results found near Caerleon.

V.—NOTE ON THE CAUSE AND NATURE OF THE ENLARGEMENT ON SOME CRINOIDAL COLUMNS.

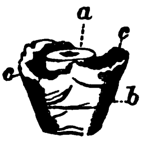
By JOHN ROFE, F.G.S.

AMONG a great number of specimens of *Crinoidea* from the Mountain Limestone collected by me during several years past, there are many parts of columns which shew an enlargement of the diameter or bulging similar to that described by Miller as representing "the remedial effect of calcareous secretion in repairing an injury of the joints of the stem," and some few portions have occurred having the appearance of a small column rising from the centre of a larger one as shewn in Woodcut *fig.* 1.

These last, for some time, were a puzzle not only to myself but to several friends better able to give an opinion on the subject. The small column *a* seems to be growing from the centre of the larger one without any appearance of a head or of side arms, and without any apparent cause; but further examination of a large number of specimens, an accidental fracture of one of them, and the subsequent dissection of others, suggest an elucidation of this difficulty, and of the cause and nature of these enlargements generally, and at the same time give a clue to the process of the growth of these Zoophytes.

The column of a Crinoid appears to have been not unfrequently used as a place of attachment for Corals, Bryozoa, or Serpulæ. Phillips (*Geol. of Yorks.*, vol. ii, pl. 1, fig. 61) figures the *Calamopora parasitica* on a stem, and MM. Edwards and Haime (*Monographs Pal. Soc.*) giving it M'Coy's designation Favosites, also figure and describe it as usually adhering to the stem of an Encrinite. Another Coral, with which this note is more particularly connected, is described by McCoy as *Jania crassa*, and subsequently as *Cladochonus crassus*, and he states that "the mode of attachment of the young is most usually by the early branches growing in a circle round a Crinoidal stem." It is over and around the coral thus attached to the Crinoidal column that the enlargement above alluded to is very frequently formed. The coral having fixed itself to and surrounded the column prevents its further natural growth laterally; but the zoophyte when enlarging its column, which it evidently effected by secreting and depositing fresh shelly matter on the outside, encloses the body or cup of the coral with the column, and by so much increases the size. Certainly in most cases, and probably in all, the divisions of the ossicula of the column are carried round the intruder, and shew on the outside as at *b, fig.* 1.

The specimen *fig.* 1 is evidently a section of one of these enlargements broken across, from which the coral has been removed, probably at the time of fracture. In my collection there is nearly half the circle of a Jania which has thus been removed from a column to which it does not shew any appearance of having been attached further than by close contact. *Fig.* 1 *c.c.* indicate moulds left in the enlarged column from the coral having been removed.



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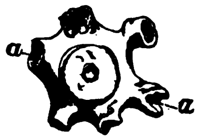

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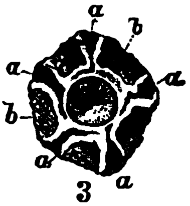

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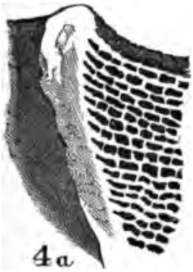
Fig. 2 is a small fragment of a column with the Jania surrounding it, but not enclosed with shelly matter. Specimens in this state are very rare, and probably may be accounted for by the death of the Crinoid occurring before the enlargement of the column was made. *a.a.* shew the calices of the coral.

Fig. 3 is from a section cut across an enlargement of the column where the coral is surrounded by the Crinoidal matter. It may be here seen, as above stated, that the coral has attached itself to the column, and by gemmation eventually surrounded it; after which the Zoophyte, whilst increasing the size of its column, has enclosed the coral by a sort of exogenous secretion of shelly matter, as indicated in the section at *b.b.*; *a.a.* being the calices of the coral which apparently were left open whilst the coral lived, but in some specimens they are entirely closed in. This specimen also illustrates what is above stated in respect to *fig.* 1, for it will at once be observed, that if the coral is removed there would remain the small central column in the middle of the larger one, as in that figure.



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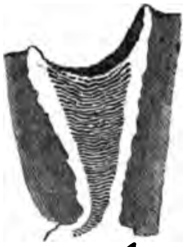

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To satisfy myself that this process of growth is common to other Crinoidea and in other geological formations, I have had a similar enlargement in the column of an Apiocrinite, from the Bradford Clay, cut both vertically and transversely, and find that here also the enlargement is due to the envelopment of some foreign substance attached to the column, by a deposition of fresh shelly matter over and around it.

In the specimen *fig.* 3, one of the Corallites is well preserved, and shews a structure which fully justifies the doubt of MM. Edwards and Haime as to the affinities of this Coral (*Brit. Fossil Corals*, p. 164). *Fig.* 4 is a magnified section of one of the calices, and *fig.* 4*a*. is a more highly magnified view of part of the same. It appears to be a tabulated coral, and, so far as I know, not yet fully described. I am indebted to Mr. Henry Woodward for calling my attention to the structure of the coral, as I should probably have overlookod its peculiarity, not being myself so familiar with this family as with the *Crinoidea*.

VI.—NOTES ON THE GEOLOGY OF LUDLOW.

By ROBERT LIGHTBODY, F.G.S.

I HAVE long thought that the vallies of the Onny and the Teme, both above and below Ludlow, had once formed an estuary, and that the promontory on which the town stands had been thrown up by some convulsion blocking up the valley, and turning the part above the town into a lake, which (by faults or otherwise) eventually caused an opening for the Teme between the Castle and Whitcliffe.

Lately, in making a drain on the N.E. side of Castle-street, a quantity of rather coarse, and very well rounded gravel was exposed *in sitú*, and below it was a bed of fine brown argillaceous sand. The pebbles were Silurian, chiefly Lower Ludlow. One which looks like Wenlock, contained *Stromatopora concentrica*; another mass was composed entirely of *Rhynchonella navicula*, from the band at the top of the Aymestry Limestone.

This appears to confirm most appositely my original opinion, as the gravel is very similar to that found in the bed of the valley, both above and below the town, and appears to have been elevated with the site of the town. It could hardly have been deposited *since* the elevation. The line of fault, which appears to have accompanied the upthrow, runs east and west (about 100 yards north of this gravel), and I believe is crossed by another fault, running between the Castle and Whitcliffe, and giving passage to the Teme.

About half a mile east, at the Gravel Hill, and at 40 feet higher, there is a fine bed of gravel, but of a very different kind, consisting principally of the debris of the Old Red, chiefly Cornstone, and which makes binding and solid-surfaced gravel walks, in consequence of the clay mixed with it, whereas the lower level gravel, as well as the small outlier, which I first mentioned, is perfectly loose, and consists principally of Silurian and Cambrian pebbles, washed down from the upper Onny valley and mixed with sand, which sometimes occurs in thin beds.

In the first instance, when was this Upper Gravel deposited? It must have been formed at the time of the denudation of the thick series of Old Red Beds, that once filled up the interval between the Titterstone, and Brown Clee Hills; the Clee Hills themselves being preserved by the capping of Basalt spread over them.

Secondly, at what level? Was it originally washed into the bottom of the valley, and then elevated to its present position (as I have assumed the deposit of gravel in the town was), or was it formed at some very remote period, when its site was part of the lowest ground in its neighbourhood, and received the debris of the Cornstone beds above it? Or is it not probable that both these causes influenced its position? Its site being on the platform that extends Eastward from Ludlow, towards the Titterstone Hills, seems to favour the elevatory theory.

However, a very long period must have elapsed since the deposit of this gravel, as not only is the valley cut down to the depth of probably 100 feet, but is covered by a thick bed of rounded gravel composed almost entirely, as before mentioned, of the debris of the Cambrian and Silurian rocks. There appears to be no trace left of the Cornstone gravel, which seems all swept away, except the one outlier noticed here. I do not know of any other gravel of the same Cornstone quality in this neighbourhood. The thick bed of Silurian and Cambrian gravel is found South of Ludlow, on both banks of the Teme, and is excavated largely for ballast; Mammoth teeth have been found in it both at Wooferton S., and at Middleton, N.E. of Ludlow.

There would appear to have been at least three periods of elevation—First, when volcanic action heaved up the two Clee Hills, elevating at the same time the whole Old Red and Carboniferous strata, and no doubt cracking and faulting them in various directions. Thus the action of the sea and rain was enabled to wear down all the beds, except where they were protected by the sheets of Basalt covering the summits of the Clee Hills.

There was probably another series of gradual upheavals, on one or both sides of the Teme valley, which enabled the river to cut down its bed much deeper relatively to the high level gravel, and which was consequently left nearly 100 feet above the present level of the valley.

At that time probably, what is now the course of the Teme and its affluents, was a strait or estuary open to the sea (just as the vale of the Severn is supposed to have been), but it is now occupied by a thick bed of gravel composed of the debris of the rocks of the Longmynd Stiperstones, and other hills of Cambrian and Silurian age. This gravel is loose, and intercalated with thin beds of red sand, which increase in thickness near Church Stretton (as seen in a ballast pit near the Railway), as if they had originated from a wash of the Permian beds near Shrewsbury, through the narrow strait at Stretton.

The third upthrow has, I conceive, given rise to the ridge on which the town and castle of Ludlow stand, carrying up with it a portion of the gravel that once covered the bottom of the valley, and damming the water above it, until the river eventually found its way through the cracks produced by the upheaval, and thus formed its present course.

In favour of this view, there is an undoubted fault running across the top of Corve-street eastwards, under the north side of the Churchyard and Castle, and thence straight up towards the gorge of the Teme at Downton Castle, leaving a depressed angle of Old Red on the north, as far as Downton Bridge, and heaving up the Ludlow beds on the south. This fault is not laid down in the Survey Map; but in the days when this district was surveyed there was less attention paid to this subject than at present, and I hope (if my view be correct) that in a future edition it may be inserted. This main fault (which is accompanied by several minor ones—also not laid down—and which probably aided in directing the course of the river) runs in a line radiating from the Titterstone and slightly diverging from the principal fault which is laid down in the district map as running through Leinthall Earls and Moor Park, to the Titterstone Hills, throwing up the Ludlow and Aymestry beds at Tinker's Hill and Caynham Camp, in the midst of the Old Red to the south-east of its course.

VII.—NOTE ON A NEW TRILOPHODONT CRAG MASTODON.

By E. RAY LANKESTER, B.A. OXON.

THE collection of Mr. Baker, at Woodbridge, contains a tooth from the Suffolk Bone-bed, indicating a *Mastodon* of the section *Trilophodon.* The tooth appears to be the upper penultimate molar of the left side. Its chief peculiarities are its great breadth, approaching *M.* (*Trilophodon*) *tapiroides;* the shortness of the ridges, the cingulum well marked in parts; the absence of a posterior and presence of an anterior talon. It apparently belongs to Falconer's section, "Colliculi obtusi—valliculæque transversæ." From a number of measurements and examinations of specimens of *M. angustidens* in the British Museum, of *M. Borsoni* and *tapiroides* in Paris (which I have to thank M. Lartet for very kindly showing to me), and *M. Borsoni* at Le Puy in the Haute Loire, I consider that this tooth comes nearest to the corresponding tooth of the huge Pliocene *Mastodon Borsoni*, though the cingulum and talon (very variable parts of the tooth) are unusually marked in Mr. Baker's specimen.

Not the least interesting part of the specimen under notice is the presence of a matrix occupying the valleys of the tooth, undeniably identical with the *sandstone nodules* which I have described as containing a fauna differing from that of the Red and Coralline Crags, and approaching the Belgian Diestien beds, containing *Pyrula, Conus,*[1] a small species of *Cassidaria* hitherto mistaken for *Nassa conglobata* and *Isocardia* in comparative abundance. This Mastodon tooth is the first specimen of terrestrial mammalian remains I have seen invested with the sandstone matrix. It furnishes the direct evidence which was wanting to prove that the terrestrial fauna of the Suffolk Bone-bed, like the Cetacea and sharks, was earlier in date not only than the Red and Coralline Crags, but than the sandy deposit which embedded it and the breaking up of which furnished the bones and sandstone nodules of the Suffolk Bone-bed—an old Eocene clay furnishing the so-called coprolites, crabs, etc.

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[1] The *Conus* is given on the authority of Mr. Searles Wood.

The Rev. J. Gunn speaks of the "*stone*-bed" at Sutton in a recent letter to this Magazine. It is better to keep "stone-bed" for the Norfolk area, and to speak of the "Suffolk *bone*-bed," since their identity is not proved. Mr. Roper's collection is no doubt interesting, but Mr. Prestwich's discovery of Mammalian remains beneath the Coralline Crag needs no confirmation. In 1862 I worked in the Suffolk bone-bed in that position, and, in two separate papers, in 1865, had pointed out the fact of its occurrence with Mammalian and other remains, at the base of both Crags, three years previously to Mr. Prestwich's recent paper. One would suppose that this relation of the beds in question should be now an accepted fact, and I therefore cannot regard it as "a singular coincidence" that Mr. Roper obtained Mammalia from Sutton.

A cast of the Mastodon tooth noted in this communication has been placed by me in the British Museum. It is intended to figure and describe it fully elsewhere.

Mr. Baker's fine collection also contains another (making three specimens known) premolar of the upper jaw of my *Hyœna antiqua.*

NOTICES OF MEMOIRS.

I.—THE CENTENARY OF WM. SMITH'S BIRTH.

W. SMITH, born March 23, 1769. Died Aug. 28, 1839.

> "If in the pride of our present strength we are disposed to forget our origin, our very speech would bewray us; for we use the language which he taught us in the infancy of our science."
>
> —Sedgwick, on presenting the Wollaston Medal to W. Smith.

IN March last (within a few days of the hundredth anniversary of Smith's birth) a lecture was delivered at the Royal Institution, Bath, on "Wm. Smith, the Father of English Geology, during his residence near Bath," by W. STEPHEN MITCHELL, LL.B., F.L.S., F.G.S.[1] The object of the lecture was to revive the memory of William Smith in Bath,[2] and to call out all local reminiscences. We especially select for notice the sketch of the growth of his geological ideas.

The Lecturer pointed out that the sources of information were—

1. The memoir of W. Smith, by Prof. Phillips, his nephew.
2. The address of Sedgwick in announcing the award of the Wollaston medal.
3. Reminiscences of early life written by Smith himself, some of which are printed by Fitton in Phil. Mag. 1833, p. 38, etc.

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[1] The notice of the Lecture has been purposely delayed as it was anticipated that further local information might have been added. With the exception, however, of some dates obtained by Mr. Mitchell from the minute-book of the Coal Canal Company, this hope has not been realised.

[2] Since this was put in type, we hear that the Committee have agreed to place a tablet on the walls of the Institution in Bath, to commemorate Smith's connection with that city.

4. A Paper by Farey (Smith's Boswell), Phil. Mag., March, 1818.
5. Obituary Notice in Geol. Journal.

It is difficult to make these agree in the matter of dates. Mr. Mitchell believes the reminiscences printed in Phil. Mag. 1833, are most trustworthy, as they were written by Smith himself in 1804. Although Smith was present when Sedgwick gave his address, and the facts were supplied by himself, yet this was in 1831, and his memory in 1804, it is thought, was more likely to be accurate. Following then his own (1804) account of himself, it appears that after surveying and noticing the different kinds of ground in various parts of England at the age of 22, he settled in Somersetshire in 1791, at High Littleton, a village within a few miles of Bath. He says:—"The discoveries of *regularity in the strata* . . . . . chiefly originated in surveys of estates and collieries in Somersetshire, where I found at High Littleton the same red earth sunk through for coal."

His next observation was on the *dip* of the strata.

"My observations on the superposition and continuity of the strata were greatly extended in 1792; and in the following year (1793), by taking levels for the proposed Somersetshire canal, I proved the Red Marl, Lias, blue marl, and Inferior Oolite . . . . . to be generally inclined to the east." The Somersetshire Coal Canal Bill passed April 8, and received Royal assent April 17, 1794. In August, 1794, Mr. Palmer, Mr. Perkins, and "Mr. Smith, the surveyor" were appointed by the Canal Committee to make a tour through England, which extended as far north as Newcastle. This gave Smith an opportunity of confirming his views. The party returned to Bath, and on October 3, 1794, gave in their report.

The next quotation from William Smith's reminiscences is of importance,[1] as showing how Smith has recorded his *next step*, the identification of the strata from their organised contents.—The Somersetshire Coal Canal consists of a main line and a branch to Radstock, but with this branch William Smith had little to do. The main line runs from near High Littleton to Dundas aqueduct, where it joins the Kennet and Avon Canal; the entire length being little over ten miles. Tracing its course from High Littleton it passes for about three miles over New Red marl, then turning north-east, crosses a strip of Lias for about three quarters of a mile, and near Withy Ditch it first enters the Sands, known as Upper Lias Sands or Inferior Oolite Sands. It then meets the hills of Inferior Oolite near Dunkerton, and after again crossing a narrow valley of the Sands, it continues on the Inferior Oolite to Combehay. Here for about a quarter of a mile it lies on Fuller's earth; then from there to South Stoke is again on Inferior Oolite. At South Stoke there is a great change of level in the canal, and from here to the end of its course it is on the before-named Sands.

"For six years," writes William Smith, "I was resident engineer on the Somersetshire Coal Canal, which put my notions of coal stratification to the *test of excavation;* and I generally pointed out to contractors and others, who came to undertake the work, what the various parts of the canal *would be* dug through. But the great similarity in the rocks of Oolite, on and near the end of the canal towards Bath, required more than superficial observation to determine whether those hills were not composed of one, two, or even three of those rocks, as by the distinctions of some parts seemed to appear. These doubts were at length removed by more particular attention to the site of the organised fossils which I had long collected. *This discovery* of a mode of identifying the strata by the organized fossils respectively imbedded therein, the sharpness of those in their primitive sites, contrasted with the same fossils rounded and water worn in gravel, led to the most important distinctions," p. 40. Phil. Mag. 1833.

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[1] In the *Bath Chronicle* report of the lecture it is given in the wrong place, and thereby loses its chief interest.

"The superintendence and execution of the canal I had before surveyed confirmed the notions previously formed of the strata; and the canal *excavations*, and the new quarries opened, produced organized fossils for the identification of several strata which could not otherwise have been distinguished" (p. 42).

This seems to fix on the valley between Dunkerton and Dundas as the *place* of Smith's discovery, Now as to its date. Sedgwick speaks of his having succeeded as early as 1791 in identifying strata by means of their fossils. In the minute book of the Canal Committee under date July, 1795, is an order to Bennett and Smith to stake out the Dunkerton portion of the canal. Advertisements in the "Bath Chronicle" of the period state that the committee will be ready to receive contracts after June 2nd, 1795. Smith remained in the employ of the company till June 5th, 1799. Assuming that the excavations in the Oolites to which he alludes were made early in the course of the work, his discovery cannot well be put earlier than 1796.

In 1791 he had perhaps noticed a difference between the fossils of the Lias and those of the Coal strata.

Everybody knows that it was in June, 1799, his first table of the order of British strata was drawn up. There were four works published in which the principles of "strata identified" were made known before Smith published anything himself, as shown in this table.

His Own Publications.	Publications of Others.
1799. MS. table of strata.	
1801. Prospectus of work never published.	
1806.	Farey. Phil. Mag., 1806, p. 44.
1811.	Farey. Derbyshire.
1811.	Parkinson. Geol. Soc., vol. I., Trans.
1813.	Townsend's Moses.
1815. Memoir to map.	
1816. "Strata identified."	
1817. Organized fossils.	

Mr. Mitchell traces the gradual spread of Smith's notions and the modification of them held in more recent times, but this, though very well in a popular lecture is too well known to need a place here. *We must* also, for want of space, omit the interesting notice of the employment of William Smith by the Bath Town Council, on the failure of the supply in the hot springs in 1812. As early as 1808, a minute relating to this subject may be seen in the Corporation books.

The connection of Wm. Smith with Bath during the development of his geological ideas is thus summarized.

The examination of the district between High Littleton and BATH first led him to suppose a regularity in the succession of *all* the strata: the planning of the Somersetshire Coal Canal near BATH was the cause of the tour through England which enabled him to confirm his supposition: the difficulty in distinguishing "the Oolitic rocks on and near the end of the canal towards BATH" led him to "the *discovery* of a mode of identifying the strata by the organized fossils respectively imbedded therein."

The *first* collection of fossils stratigraphically arranged was made by him at Cottage Crescent, BATH.

The *first* table of the order of the strata was drawn up by him at Pulteney Street, BATH.

The *first* geological map known is his map of the district of BATH.

The *first* geological map of England was coloured by him while living near BATH.

The *first* announcement of the publication of a geological map of England, was his "prospectus" dated from Midford, BATH.

The *first* introduction of his discovery to public notice was through the friends he made in BATH.

II.—THE METAMORPHISM OF ROCKS.

By the CHEVALIER CRESCENZO MONTAGNA.

[Nouvelle Théorie du Métamorphisme des Roches fondée sur les phénomènes de fossilisation des Animaux et des Plantes de tous les Âges Géologiques. 3 Plates. Naples, 1869. pp. 127. London: Trübner and Co.]

THE term Metamorphic is usually applied to rocks whose original structure has been obscured. Contact with igneous rocks in a molten state was first taught by Hutton, and has been generally accepted as the principal cause.

But there are many forces, both chemical and physical, which tend to produce change in rocks, and it has been well said that all rocks are in a metamorphic condition, since all have suffered some changes subsequent to their formation, and changes they are continually undergoing. Professor Montagna takes this comprehensive view of the subject, and regards all rocks as metamorphic.

Allowing the means and causes which continually modify the crust of the earth to have been always the same, he considers the difference in rocks of similar origin to result in general from a longer series of metamorphic actions. From Tertiary strata downwards there are metamorphoses more or less profound; and the author discusses these changes from the evidence furnished by the fossil remains, whether of plants or animals. This mode of treating the subject he considers more positive than if the evidence were derived solely from lithological characters, as the recent and unchanged forms of life may very readily be compared with the fossil forms, and their structure and composition is of a more definite character.

The work is divided into seven articles. Some of the principal theories of metamorphism are first pointed out and discussed; the alteration by heat of gneiss and other rocks exclusively termed metamorphic is objected to. When, as is sometimes the case, the stratification is apparent, and the character uniform, of beds hundreds of metres in thickness, the evidence seems to the author at once opposed to the igneous theory. A very elevated temperature would in places have destroyed every trace of stratification, while the change would be gradual, fading away from the point of contact with the igneous rock. To account for the uniform character we should have to suppose that the mass was entirely surrounded by molten material. The author points out the slight facility with which the majority of rocks conduct heat.

Several instances are quoted where rocks, undoubtedly of sedimentary origin, have originally been taken for igneous and eruptive rocks. It is also mentioned that volcanic lavas may, by atmospheric influence, be decomposed into clays, and undergo the same transmutations as the aqueous rocks.

The petrifaction of organic remains teaches us that the particles composing rocks do not remain inert; they indicate molecular changes.

Some space is devoted to the changes that are evidenced by mollusca. Many instances of replacement, both entire and partial, are noticed. It is evident in general that this substitution must have proceeded atom by atom.

In many instances the shell has been more or less removed without being replaced; but the author remarks that, during his long researches, he has in no instance observed the shell entirely dissolved in such a manner as to allow the shock to be heard of the nucleus inside the cavity. Thus occasionally new matter may fill these cavities, and so replace the shell in its general form, without replacing the intimate structure.

The most metamorphosed rocks have undergone the greatest amount of chemical action, or a repetition of metamorphic actions. In the earlier stages the changes were in a great measure confined to the organic remains, and these seem to have suffered much, so that in the more altered rocks they are greatly changed, or even destroyed.

Crystallisation appears to be the last stage of metamorphism,—it often destroys the organic remains.

Professor Montagna, however, announces his discovery, in granite, of vegetable remains, consisting of portions of *Lepidodendron* identical with species found in the Coal-measures; also of *Lepidodendron sexangulare* in a compact serpentine, and in certain porphyries. Vegetable remains are also cited as occurring in syenite. About seven-tenths of the numerous specimens of granite and granitic rocks examined by him prove their aqueous and stratified origin, by *yielding* plant-remains, which are more evident the finer the grain of the granite. He remarks that these vegetable remains forbid the idea of heat being the agent in producing the metamorphism of the rocks. And he is confirmed in the opinion expressed in his "Generazione della Terra," that granite has been formed solid on the surface of the globe.

All the serpentines he has observed have yielded fossil plants, as *Lepidodendron*, *Asterophyllites*, *Stigmaria*, etc.

Serpentine and ophiolitic rocks of schistose or massive texture show their metamorphic origin in another way; they have been detected graduating into clay.

The author has concluded that metamorphism results from molecular changes. "The chemical changes that take place in a sedimentary rock, and also the formation of a crystalline structure, which we have recognized as the more frequent and remarkable the longer the metamorphic action has continued, are themselves only molecular movements produced by particular combinations and decompositions due to the nature of the elements."

The production of these changes he concedes to electricity.

"There is nothing but electricity which, among the forces known only by their effects, could produce all the phenomena of which we have spoken; we know no metamorphic phenomenon which it could not explain."

The origin of lodes may also, he thinks, be explained by electrodynamic forces.

Finally he remarks on the constancy and long duration of certain plants being opposed to the metamorphic views of Darwin, and concludes by proposing a new classification of the older rocks in reference to the amount of metamorphism they have undergone.

The three plates illustrate fossil plants from several rocks generally supposed to be eruptive or azoic.

REVIEWS.

I.—The Production of the Precious Metals: or, Statistical Notices of the Principal Gold and Silver Producing Regions of the World, Etc. By W. P. Blake, Commissioner from the State of California to the Paris Exposition of 1867. New York: Putnam and Son. London: Trübner and Co. 1869.

THIS valuable report, prepared by Mr. Blake at the request of the United States Commission, contains, in as compact a form as such a subject admits of, descriptive and statistical notices of the chief gold and silver producing regions of the world. It differs from the admirable work of Mr. Phillips, published in 1867, in treating less of the methods adopted in the extraction of the precious metals from their ores than of the yield and extent of resource of each country in this particular. The noble metals are considered in succession, and they are discussed, each in turn, in respect to the localities producing them, the statistics of their yield in most cases being given down to the end of the year 1867. Fully alive to the many difficulties attending the collection of mining statistics, Mr. Blake appears to have observed a wholesome caution in compiling his report, and the results which he lays before us are therefore the more acceptable. From a work so crammed with facts it is impossible to do more than give an example or two, taken almost at random, of the interesting statistics it contains. In the year 1867 the United States, with its Territories, produced 71 millions of dollars of gold and silver bullion, about seven-ninths of this being of the former and two-ninths of the latter metal. California supplied gold only, and that to the amount of 25 million dollars; Nevada on the other hand yielded six million dollars of gold and more than twice that amount of silver, or the major part of all the silver raised in the country. The silver production of Nevada, owing to the falling off of the yield of the Great Comstock vein, is diminishing; but this loss is to a great extent made good by the discovery of the White Pine silver beds, where, by the way, large masses of chloride of silver come to the surface, and are hewn out with axes. These new finds, Mr. Blake believes will swell the annual production of silver in the States beyond what it has been hitherto. The total gold and silver bullion produced in the States during twenty years, ending in 1868, he estimated to be 1,075,500,000 dollars in value.

Passing on to the gold regions of South America, Central America, Australia and New Zealand, which are treated of in one chapter, he finds that the yield of gold of the Brazilian mines culminated in the middle of the 18th century. The native gold from some localities in the empire is noticeable for containing from 7 to 11 per cent. of palladium. The production of gold in Victoria is likewise declining, from 1,627,000 ounces in 1863 to 1,392,000 ounces in 1867. This, however, is ascribed to the withdrawal of a number of the miners to other pursuits. In New Zealand gold was first discovered in 1842, but was not extensively worked till 1852, and the supply is now decreasing. The total yield of this colony up to December, 1864, is taken to be 1,749,359 ounces, and is valued at £6,771,730.

The next chapter discusses the gold production of the three remaining continents. The existence of gold in the Ural Mountains and in the Altai was known to Herodotus, but the precious metal was rediscovered in the first half of the last century during explorations made by Peter the Great, from which time to 1864 the Russian gold mines have yielded 500 million dollars' worth of metal. In the ancient mines on the southern and eastern borders of the Urals, wedges and hammers of copper are found, "and heavy wedges made of stone, with grooves by which handles appear to have been attached." Tusks of boars appear to have been used to scrape out the gold, and leather bags have been discovered in some of the old galleries. Coming nearer home, statistics assume a more modest guise. The gold workers of the Rhine in the year 1846 earned a franc and a half a day, and in 1853 the golden Rhine produced but 4,446 francs' worth of the king of metals. The Vigra and Clogau mines, in

Merionethshire, the most productive in Wales, yielded £20,000 worth of gold in 1862, when a rich pocket of disseminated gold was struck. The total yield of the North Wales district up to April, 1866, has been 12,800 ounces. Mr. Blake concludes this chapter with an interesting table giving the relative amounts of metal raised in the chief gold-producing countries of the globe in the year 1867, which shows that the United States contributed 43 per cent., Australia 24, Russia 11, New Zealand 4·6, Central America 4·0, Borneo and East India 3·8, China and Japan 3·8, and so forth.

Entering on the history of silver mining, Mr. Blake provides us with an interesting chapter on the workings in the State of Nevada. Here we read of the Great Comstock Lode, which, though discovered scarcely ten years since, had already at the end of 1867 contributed 80 millions of dollars in value to the bullion of the world, that is to say, 28 millions in gold and 53 in silver. Lists of the several claims, with the number of their hoisting and pumping engines and batteries, detailed statements of the cost of the workings from year to year, in fact, a host of statistics highly valuable to the mining engineer, are tabulated. Such names as Segregated Belcher, Yankee Blade, Fenian Star, and Gouge-eye, for mines, are suggestive of the mode of life and manner of men in Nevada. Colorado will soon become celebrated, as well for silver as for gold, large veins, not only of argentiferous galena, but of true silver ores such as sulphides, antimonides, and of rich chloride having been struck. The chapter on the silver regions of Mexico, Central and South America, contains little new matter. Of the European mines those of Norway seem to have been the best represented at Paris ; among the specimens from Kongsberg being a cube of silver three quarters of an inch in diameter, with small and perfect octahedral planes.

The remainder of Mr. Blake's report is devoted to a detailed consideration of the aggregate production, consumption, and movement of the precious metals, and of the unification of gold and silver coinage, subjects which address themselves more especially to the student of political economy.

II.—CHIPS AND CHAPTERS; A BOOK FOR AMATEUR AND YOUNG GEOLOGISTS. By D. PAGE, LL.D., etc. 8vo. pp. 303. Edinburgh: W. Blackwood and Sons. 1869.

DR. PAGE has selected from his unpublished addresses and papers, two dozen, which form a readable and entertaining volume deserving to be consulted by the practical geologist as well as by those to whom the author in his title page specially addresses it. The essays are on very different subjects, and of different merits. In accordance with the spirit and object of our journal we necessarily give the first place to those recording observations and discoveries made in the field, or giving the history of any portion of our science. The paper on Dura Den may illustrate both of these classes. Without the wonderful word-paintings of Hugh Miller, and the captivating style of the "Old Red Sandstone," there is here a clear statement of the present state of our knowledge in regard to this remarkable store-house of Devonian fishes. Perhaps the most interesting chapter in the volume is that on Scottish Geology, containing a narrative of the progress made in the geological exploration of Scotland by the Government Surveyors, and by individual enterprise, together with an enumeration of the problems yet requiring solution. While the amount of work done is great, Dr. Page clearly shows that it has but begun.

We greatly regret that Dr. Page did not in his selection confine himself to such papers as those to which we have alluded. We are seldom able to agree with the author in his theories or dreams. In development views he out-Darwins Darwin. The illustrious expounder of Variation by Natural Selection sought to explain the origin of the present state of things—Dr. Page carries his development dreams into the future, and is not afraid to tell us of the "Whither" of man and of his associates, all the necessarily higher progeny of the present order of beings! Still less do we sympathise with his Geologico-theological papers. If Biology is not Dr. Page's *forte*, still less so is Theology. We do not know whether, in the encyclopedian scheme of Manuals with which Dr. Page was lately or is still engaged, he had in contemplation a Manual of Theology. Our author would certainly produce something novel in this direction, but if he should treat on the history of the science, we would humbly recommend his entering on some preliminary investigations, as we doubt whether he would find a single theologian among his countrymen who would accept of the statement on page 112 in his Essay on Geology and Modern Thoughts, as at all in accordance with his creed.

Dr. Page has done real useful work, and aided so largely to promote a taste for geological pursuits—especially among the young—that we do not like to find a single leaf of his book taken up with vain speculation, in promoting which too many writers are already engaged. There is still so much real work to be done in the fair and legitimate field of geological research that no one need dream now-a-days.

III.—NOTES ON THE LATER EXTINCT FLORAS OF NORTH AMERICA, with Descriptions of some New Species of Fossil Plants from the Cretaceous and Tertiary Strata. By J. S. NEWBERRY. 1868.

THE author brings together all the published materials regarding these floras, and adds a large amount of new facts and descriptions of many new species. The Cretaceous flora of North America had so modern an aspect that, notwithstanding the American geologists insisted that stratigraphically it was of Secondary age, Heer and others who described the specimens held it to be Tertiary from the character of the fossils. In Europe the Secondary, Tertiary, and Recent Floras are widely separated from each other. In North America, however, the genera now living form a larger proportion of these extinct floras than the genera which have disappeared. Among existing genera found in Cretaceous deposits may be enumerated *Populus*, *Salix*, *Quercus*, *Magnolia*, and *Platanus*, together with *Diospyros*, *Aristolochia*, *Sassafras*, *Liriodendron*, *Taxodium*, *Cupressus*, etc., some of which are confined as living plants to the American Continent, though they occur in the Tertiary beds of Europe. With these are associated a few which have disappeared entirely from North America, such as *Cinnamomum*, *Cissus*, *Ficus*, *Araucaria* and *Salisburia*.

Professor Newberry adds very greatly to our knowledge of the flora of the Tertiary strata in America. In addition to the genera already named he finds many other forms which exhibit a much nearer approach to the vegetation of the present day. These consist of such genera as *Cornus*, *Negundo*, *Carya*, *Sapindus*. *Aralia*, *Amelanchier*, *Planera*, *Rhus*. *Sequoia*, and *Thuja*. A considerable affinity may be observed between these genera and the fossils of the Miocene beds of Europe, as well as with the existing flora of Japan and China, though they more closely resemble the living vegetation of North America.

It is not a little remarkable that some living American genera found in the Cretaceous rocks have not yet been discovered in these Tertiary beds. This may, however, arise from the little that has yet been done in the way of exploring these beds. Professor Newberry has made a valuable beginning. We would venture to suggest the great importance of good drawings of the forms named and described. This is especially desirable when materials so unsatisfactory as leaves generally are, are all the data on which the identification of genera and species can be based.

IV.—TRANSACTIONS OF THE MANCHESTER GEOLOGICAL SOCIETY. Part 3. Vol. VIII. Manchester. 8vo.

UNTIL we received the newspaper report of a recent meeting of this Society, we were at a loss what to make of this part of its Transactions. It seemed to us that by some mistake the sender had put an old number in the cover addressed to us. With no indication of the period of publication on the title page or elsewhere, and having only the dates when the papers were read, "1842-3," the student consulting this part would of necessity conclude that it was published in 1843. As personal claims to a particular observation or discovery can be established only by publication, it is obvious that such a proceeding as this is reprehensible. We would further be surprised if the different authors of the papers have not a more serious charge against the Council of the Society. The Secretary may have been asleep for a quarter of a century, but geologists have been advancing, and none more so than the authors whose names are prefixed to the essays here published. It would be doing a great injustice to suppose that, with all this progress that has been made in our knowledge of the Glacial Period, Prof. Harkness still adheres to the notions contained in a paper read in January, 1843, or even that he considers those views deserving to be brought under the

attention of geologists in 1869 in the words which he used more than a quarter of a century ago. The publication of the papers must be equally objectionable to the other authors.

According to a newspaper report to which we have alluded this is only a small portion of the strange vagary of the Secretary or the Council of the Manchester Society. It is there asserted that all these papers had already been printed by the Society. We have taken the trouble to verify this statement, and in doing so we find that when first published they appeared as abstracts, the "Editor" stating that he must be "responsible for the fidelity with which the views of the authors are abstracted." In the part before us the various authors are made responsible for these same unaltered abstracts! Furthermore, one of the six republished papers has had the remarkable honour of having appeared three times in the Society's publications—on the first and last occasions as the joint production of two authors; while in the intermediate appearance, having received some verbal alterations, it is ascribed to one of them!

REPORTS AND PROCEEDINGS.

Geological Society of London.—June 23rd, 1869. Prof. T. H. Huxley, LL.D., F.R.S., President, in the Chair. The following communications were read:—

1. "On two new Species of *Gyrodus.*" By Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., V.P.G.S.

The author remarked upon the characters of the genus *Gyrodus*, of which he described two new species, namely, *G. Goweri*, from a deposit of Oolitic age on the east coast of Sutherland, having the scales covered with a somewhat reticulated raised pattern, interspersed with granules; and *G. coccoderma*, from the Kimmeridge Clay of Kimmeridge, having the scales adorned with a multitude of symmetrical granules, which show no tendency to coalesce. The author also described a vomer of *Sphærodus gigas*, bearing teeth of the form usual in that genus, and remarked that this specimen established the validity of the genus *Sphærodus.*

2. "Note on a very large Saurian Humerus from the Kimmeridge Clay of the Dorset coast." By J. W. Hulke, F.R.S., F.G.S.

This stupendous limb-bone, 31 inches long, was obtained from Kimmeridge Bay by J. C. Mansel, Esq. It had a subcylindrical shaft, a transversely elongated proximal, and a cubical distal extremity. The distal end is mapped out by a wide shallow posterior groove, and a narrower but deeper anterior notch, into a couple of condyles, of which the inner or posterior is the larger. The anterior border of the shaft towards the proximal end rises, as if to form a deltoid crest. The cortical tissue of the shaft is remarkably dense and polished. There is not any medullary cavity, but the interior of the cortex is filled with cancellous tissue.

The author pointed out that the form of the terminal surfaces removed the bone from all the Enaliosaurians, and brought it into close relation to the humerus of existing Crocodilians, from which, however, it differed in its being less curved and by its great size.

He next referred to its differences from the humerus of the Dinosaurs *Iguanodon*, and *Hylæosaurus*, and remarked that it most nearly resembled the large limb-bone on which Mantell founded his genus *Pelorosaurus*.

3. "Note on some fossil remains of a Gavial-like Saurian from Kimmeridge Bay, establishing its identity with Cuvier's 'Deuxième Gavial d'Honfleur' and with Quenstedt's *Dakosaurus*." By J. W. Hulke, Esq., F.R.S., F.G.S.

The fossils which formed the subject of this communication were also collected by Mr. Mansel in Kimmeridge Bay. They demonstrated the existence of a Saurian having long subincurved, subretrocurved, laterally compressed, unequally convex teeth, with an anterior and a posterior finely serrated edge, loosely implanted in distinct and separate sockets, and vertically replaced by young teeth rising into the base of the large open pulp-cavity of the fang of the old tooth.

The lower jaw, of which the greatest part of the right half is preserved, is about 40 inches long. The symphisis is very long, and includes the opercular bone. The upper jaw shows a terminal, undivided nostril, not inflated laterally as in *Teleosaurus*. The lines of the jaws seem to merge into the cranium less abruptly than in the living Gavial, which gives the outline of the head a greater resemblance to *Mecistops*. The vertebræ are biconcave, and the outer surface is hollowed and somewhat overhung by the roundish articular surfaces. The transverse processes are long and directed outwards, and slightly backwards and downwards; their posterior border thick, the anterior thin. The ribs have bifurcated spinal ends. The femur, 14 inches long, resembles that of the living Crocodilians, only it is less twisted.

The structure of the jaw, the form and attachment of the teeth, and the manner of their succession, with the form of the vertebræ and ribs, proved this Kimmeridge Saurian to be a Crocodilian (and not a Lacertilian) resembling a bastard Gavial. The author next demonstrated its identity with *Dakosaurus*, Quenstedt, and hence with *Geosaurus maximus*, Plieninger; and he expressed a belief that it was also generically identical with Cuvier's Honfleur Gavial, "tête à museau plus court," and Geoffroy St. Hilaire's *Steneosaurus rostrominor*.

Discussion.—Mr. Seeley remarked that in the base of the Oxford Clay, there was what he regarded as a peculiar form of *Dakosaurus*, with two serrated ridges close together on one side of the tooth, and one on the other. Vertebræ of similar character to those exhibited occurred in the Kimmeridge Clay at Ely, but the teeth were rarely perfect. The author's conclusions confirmed his own surmises.

4. "On the Geology of a Portion of Abyssinia." By William T. Blanford, Esq., F.G.S. etc.

This paper contained a brief description of the principal geological observations made by the writer when accompanying the late Abyssinian expedition. After referring to the notices by previous explorers, he gave a list of the different formations met with, viz.—1.

Recent. Soils on the highlands, including regur or cotton-soil, similar to that found in India, and alluvial deposits on the coast. 2. The volcanic series which skirts both coasts in the southern portion of the Red Sea. This, which was poorly developed on the west coast of Annesley Bay, it was proposed to designate the Aden volcanic series. 3. The great trappean formations of the Abyssinian highlands, consisting of two groups unconformable to each other, (1) the Magdala group, consisting of trachytes and dolerites, and (2) the Ashangi group, entirely composed of dolerites, both of great thickness and formed of bedded volcanic rocks, lavas, and ashes. 4. The Antalo limestone of Oolitic age, containing *Ceromya similis*, *Trigonia costata*, and other characteristic forms. 5. Adegrat sandstone, a massive formation occupying a considerable area in northern Tigre, and perhaps representing the coal-bearing rocks known to exist north-west of Lake Dembea, but unfossiliferous. 6. Metamorphics of varying mineral character, having a general north and south strike, due to pre-existent cleavage. Some brief remarks on denudation, etc., followed.

Discussion.—Mr. Etheridge remarked on the similarity of the Oolitic specimens to those from the Cotteswold Hills, and also to those from the Holy Land. Similar fossils also occurred in the far east, and even in Australia.

The President remarked that this range was not greater than that of some recent species; and in answer to his enquiry,

Mr. Blanford stated that there were no marks of glaciation discernible in Abyssinia, the excavation of the valleys being apparently due to the excessive rainfall.

5. "On the Graphite of the Laurentian of Canada." By Prof. J. W. Dawson, LL.D., F.R.S., F.G.S.

The author described the modes of occurrence of great quantities of graphite in the Laurentian limestones of Canada. He regarded the presence and characters of this mineral as indicative of the existence of plants, side by side with *Eozoon*, at the period of the deposition of these limestones.

Discussion.—Prof. Brayley enquired whether there was any proof that the substance called graphite might not be anthracite. He did not himself know of any instance of the passage of one of those substances into the other, and regarded graphite as of chemical origin, and not as directly derived from vegetable matter.

Mr. Mallet did not think that it was possible for any organic forms to remain in a substance so purely crystalline as typical graphite. The presence of organic remains was an argument in favour of the masses mentioned in the paper being lustrous anthracite rather than graphite.

6. "On the Correlation, Nature, and Origin of the Drifts of North-west Lancashire and part of Cumberland." By D. Mackintosh, Esq., F.G.S.

In this paper the author stated the results of observations made last December, January, and February, during prolonged visits to Blackpool, Ulverstone, and Lancaster. At Blackpool repeated examinations of the drifts, as exposed on the tidal zone and in the cliffs, convinced him that there is a distinct triplex series—a hard, very stony lower boulder-clay, a middle sand and gravel, and a less stony upper boulder-clay and marl. At Blackpool the author likewise found a newer deposit of warp-clay (or Scotch *slutsh*) interstratified with and overlaid by peat and sand. On the Furness side of Morecambe Bay, the same lower boulder-clay, there called "pinel," made its appearance. After many visits to the section near the Ulverstone railway-station, he convinced himself that the pinel not only contains seams of sand, but overlies a thick bed of finely laminated sand. It wedges out upwards into an exceedingly contorted and false-bedded mass of middle sand and gravel. The pinel he found running up the hill-sides to an altitude of 800 feet. Above Soutergate, at a height of between 700 and 800 feet, he found a distinct line of demarcation between the pinel and an upper boulder-loam which lower down contained boulders of granite. The paper contained a particular description of the completely isolated island-hill called Dunnerholme, with its capping of upper boulder-clay and rounded pebbles, many of them still sticking in the funnel-shaped cavities of the underlying limestone, which they apparently helped to grind out. The author described a great thickness of upper boulder-clay near Barrow, and defined the north-east boundary of the granitic drift, which he believed could not all have come from Eskdale in Cumberland. He likewise described the naturally sculptured large boulder-stones of Stainton. On the west side of the Duddon, he could clearly trace the pinel and middle sand and gravel, and he believed an upper rubbly boulder-clay, the lower limit of which, however, was not well defined. He found all the drifts, but especially the upper, spreading out along the base of Blackcombe in the shape of a regular terrace running up into its combes, and choking up its gorges. He described the appearances presented and positions occupied by the drifts at high levels on Blackcombe, and endeavoured to trace a distinction between marine drifts, glacial moraine matter, and ordinary "screes" or fallen débris. The author gave a particular account of the enormous mounds of sand and gravel between Lancaster and Carnforth, described the mode of occurrence and striation of the limestone boulders, and traced the latter to the action of sea-ice on old sea-coasts around Warton Hill, etc. In conclusion, he considered the mode of accumulation and derivation of the drifts of North-west Lancashire, and compared them with the lower boulder-clay, middle sand and gravel, and upper boulder-clay of the splendid section, 150 ft. high, near Preston, and with the drifts of other districts.

7. "On the Connexion of the Geological Structure and Physical Features of the South-east of England with the Consumption Death-rate." By W. Whitaker, Esq., B.A., F.G.S.

The author stated that his investigation of this subject, which was carried on in conjunction with Dr. Buchanan, was suggested by the fact that improved drainage had been found to exert a marked influence upon the average number of deaths by consumption in certain districts. The chief result arrived at by an examination of fifty-eight registration districts in Kent and Sussex was, that "wetness of the soil is a great cause of consumption;" and this depends not only upon the perviousness or imperviousness of the soils, but upon their position as regards elevation and slope.

Discussion.—Prof. Brayley mentioned a paper by Mr. Mackinnon on the same subject, communicated to the Royal Society some years ago.

Dr. Duncan commented on the value of such inquiries, and mentioned that in Devonshire families living in the valleys were peculiarly liable to consumption, while those living on the hills were free from the disease.

8. "On the Volcanic Phenomena of Hawaii." By the Rev. C. G. Williamson. Communicated by Sir R. I. Murchison, Bart., F.R.S., V.P.G.S.

In this paper the author gave a detailed account of the general physical features of the island of Hawaii, noticing especially the characters presented by the volcanic mountains of the island and the results of their eruptions. The eruptions and earthquakes of 1868 were particularly described by the author from his personal observations.

9. "Notes on certain of the Intrusive Igneous Rocks of the Lake-district." By Dr. H. A. Nicholson, F.G.S.

The rocks referred to in this paper were the syenite of the Vale of St. John, the syenitic porphyry between Ennerdale and Buttermere, and the felstone porphyry of Carrock Fell. The author described the characters and position of these rocks with regard to the Skiddaw Slates on the one hand, and the green slates and porphyries on the other, and indicated that the latter series of rocks are unconformably deposited upon the purely sedimentary Skiddaw slates. The Skiddaw Slates were said to be metamorphosed where they come in contact with the intrusive masses, and the latter were regarded by the author as most probably "the roots of the ancient vents from which were derived the alternating ashes and traps which together compose almost the whole of the green-slate series."

10. "On the Fossil Myriopods of the Coal-formation of Nova Scotia and England." By Samuel H. Scudder, Esq. Communicated by Sir Charles Lyell, Bart., F.R.S., F.G.S.

In this paper the author discussed and described the species of Chilognathous Myriopods which have been detected in the Coal-measures. Of these he recognised six, viz., *Xylobius sigillariæ* (Daws.), *X. similis*, sp. n., *X. fractus*, sp. n., *X. Dawsonii*, sp. n., *X. Woodwardii* (=*sigillariæ*, Woodw.), and a species upon which he founded a new genus, *Archiulus xylobioides*. He regarded these forms as constituting a peculiar family, for which he proposed the name of *Archiulidæ*.

11. "On the Geology of the Country surrounding the Gulf of Cambay." By Alexander Rogers, Esq., F.G.S., Bombay Civil Service.

The author described the surface of the country as consisting chiefly of deep alluvial soils, derived from the denudation of the primary and metamorphic rocks surrounding the district, the former making their appearance in groups of isolated peaks, projecting, as it were, from a sea of alluvium. The author considered that this alluvium could not have been produced by the action of the existing rivers, and suggested that the Indus may formerly have flowed into the sea by the Gulf of Cambay, the land at the same time being much depressed below its present level. He indicated the evidence in favour of this view furnished by various facts in the geology of the district, and referred especially to the mode of occurrence of laterite.

Discussion.—Sir P. Egerton mentioned that the Secretary of Mr. Burlinghame, the Chinese Ambassador, had informed him that the course of the Yellow River had, within a comparatively short period, changed its course by nearly 500 miles, and by cutting off the supply of water to the Great Canal of China, had brought on the Taeping rebellion in consequence of the employment of the people being lost.

12. "On a new Acrodont Saurian from the Lower Chalk." By James Wood Mason, Esq., F.G.S., of Queen's College, Oxford.

The author described this reptile, for which he proposed the name of *Acrodontosaurus Gardneri*, as differing from *Mosasaurus* in the apparently persistent distinctness of the premaxillæ and their small development in the middle line, in the more anterior position of the nasal aperture, which is directed upwards and forwards, in the total obliteration of the maxillo-premaxillary suture, and in the absence from the cylindrical teeth of opposite denticulated ridges. The specimen was obtained from the Lower Chalk of Folkestone, about ten feet above the Chalk Marl.

13. "Rodentia of the Somerset Caves." By W. Ayshford Sanford, Esq., F.G.S.

The author has examined the Rodents from the caves of Somersetshire contained in the Taunton Museum, and found that many of them cannot be referred to species hitherto regarded as belonging to the fauna contemporary with the Mammoth in Britain. He enumerated species of *Arvicola* (including *A. glareola*, (Schreb., and *A. ratticeps*, Blas.=*Lemmus medius*, Nilsson, and a species which may be new, and for which he proposed the provisional name of *A. Gulielmi*), *Lemmus* (*L. norvegicus*, *Desm.*), *Lagomys* (*L. spelæus*, *Owen*), *Lepus* (*L. diluvianus*, Pict., *L. timidus*, Linn., *L. hibernicus*, Bell, and *L. cuniculus*, Linn.), *Spermophilus* (*S. erythrogenoides*, Falc.: the citation of *S. citillus* by the author and Mr. Boyd Dawkins is founded on a mistake), and *Cricetus* (*C. songarus*, Pall).

The next evening meeting of the Society will be held on Wednesday, the 10th November.

Edinburgh Geological Society.—The tenth meeting of this Society was held on 1st April, when the following communications were read:—"1. Note on Craig Phadrich, a vitrified fort near Inverness," by George Anderson, Esq. Craig Phadrich occupies the terminal rocky ridge (about 520 feet high) of the long chain of mountains which skirt the west of the great glen of Scotland, with the frontlet opposite to it on the Ross-shire coast, that of the Ordhill of Kessock, also a vitrified fort. It constitutes the advanced beacon station on the Moray Firth, from which signals might be passed by all the links of the chain of natural telegraphs stretching away into the recesses of the country beyond the head of the Beauly Firth, in Ross-shire, Glenstrathfarar and Strathglass, as well as in the great glen. Six or seven vitrified summits are visible from Craig Phadrich, and if the ordinary hill forts, having huge ramparts of stone round their tops, though not known as yet to contain vitrified substances, belong to the same class of antiquities, that number might be nearly doubled. On the western or easiest approach to the summit of the Ordhill of Kessock, we meet a wall of loose stones (now m[illegible] thrown down) fully fifteen feet thick, and it is not very long ago that I discovered flanking low walls on each side of it, now grass-grown, which are distinctly vitrified; and similar burnt masses I believe will yet be found on other forts which have not been thoroughly explored. In ascending Craig Phadrich, we pass along the bulging sides of an ordinary hill of Old Red sandstone, till we arrive suddenly at the base of an enormous cap or summit of hard conglomerate, with precipitous frontlets on the north and south sides, and steep ridges of approach on the west and east. These approaches were traversed and guarded by two walls or embankments—one a very strong and high one on the summit, composed of loose stones and sand and gravel, with a thinner wall about fifty feet lower down the slope, but which is the most highly vitrified. The pathway or ascent by the west side is extremely narrow, and is flanked all along by projecting masses of rock, from which loose stones could be thrown down on an invading foe; and there are besides many large loose masses which could easily be tossed over. The main entrance was by the eastern slope or approach, but the pathway ascends by a steep incline, and it then winds in a tortuous manner between the two ramparts to the gate at the summit, which could thus be easily guarded, and which was further protected by projecting walls or bastions. Both the walls are now much grass-grown, and it is at present difficult to say to what extent they were vitrified, or how far they have been overthrown or destroyed, as they undoubtedly were in other hill-forts. In the upper rampart, which has only been partially opened up or excavated, I have not been able to observe a continuous coating of vitrified matter; but the vitrified stones occur intermixed with other stones not effected by fire, and with sand and gravel, quite irregularly, though in some spots in patches of considerable size. In the lower or outer wall, and especially on the south side, where a long trench had been cut along its face, there is more of the appearance of a continuous sheet or coating of vitrified matter, consisting of pieces of gneiss, granite, mica slate, and quartz rock, with some bits of sandstone, all attached together and fused into one another. Beneath the vitrified crust, which is seldom above 12 or 14 inches thick, the rampart consists, as I have said, of loose stones, earth, and gravel; and in Craig Phadrich I have not observed, as in some similar structures, long strings of melted matter running down like one's fingers into the heap below. Another fact seems worth recording, that while the wall or rampart appears invariably to thin out as it approaches a cliff or mass of the native conglomerate rock, no part of that rock itself has been vitrified or at all affected by fire. The specimens of gneiss, old red sandstone, &c., from Craig Phadrich, exhibited more or less a tendency to a regular columnar structure.

2. "On the Coalfields of the North Pacific Coast, as affecting the Western Terminus of the Pacific Railroad." By Robert Brown, F.R.G.S., &c. The author stated that what notes he had to lay before the Society, were the result of occasional observations in the course of his wanderings between California and the Alaska during

portions of the years 1863, 1864, 1865, and 1866, and refer to the Coal supply. Mr. Brown stated that the three North Pacific Coal-fields extend from the borders of California to Alaska, and belong respectively to the Tertiary, Secondary, and Palæozoic ages—the latter being situated, as far as yet known, only in the Queen Charlotte Islands, off the northern coast of British Columbia, the exact age of which being as yet undetermined, though the coal is anthracitic, and in all probability Palæozoic. The Tertiary Coal extends from California northward through Oregon and Washington Territory, impinging the southern end of British Columbia and Vancouver Island, and extending, with some interruptions, right across the Rocky Mountains—the Miocene coals of Missouri being apparently only a continuation of the same beds. The Secondary beds, on the other hand, on the North Pacific are confined to the island of Vancouver, though in all probability they are only a continuation of the Cretaceous strata of Missouri. The Tertiary lignites of the North Pacific are throughout of Miocene age, and are associated with beds of sandstone, shale, &c. The coal burns freely, but leaves behind much slag and ash. It has been wrought at various places on the coast. 1. Monte Diabalo, California.—Here 59,257 tons were mined last year from January to August, the coal selling for eight dollars per ton in San Francisco. At Benicia it was also mined, but has been discontinued. Its analysis is—carbon, 50; volatile bituminous matter, 46; ash, 4. 2. Coose Bay, Oregon.—Its analysis shows 46·44 per cent. of carbon, 50·27 of volatile matter, and 3·19 of ash. Its percentage of coke is 49·73; but this is dark, friable, and of little value. It produces abundant gas, of a low illuminating power. It is used to some extent in San Francisco, 7,759 tons having been imported from January to August, 1868. 3. Clallam Bay, Washington Territory.—Several attempts have been made here to get good coal, but have failed to a great extent owing to the want of a harbour. Analysis—Carbon, 46·40; volatile matter, 50·97; ash, 2·63. 4. Bellingham Bay.—Here the lignite has been mined for some years with success, though it is of no better quality than the others. From January to August, 1865, 5680 tons were imported into San Francisco. Analysis—Carbon, 47·63; bitumen, 50·22; ash, 2·15. Coal crops out at various other localities—Fraser River, Burrard Inlet, islands of the Haro Archipelago, Sanetch Peninsula, the northern (Vancouver) shores of De Fucas Strait, &c.—but has not been worked. Mr. Brown was of opinion that all these outcrops were of Tertiary age, the secondary beds not appearing south of the Chemainos River. There are Newer (Pleistocene, or perhaps Recent) lignites in the cliffs of Useless Bay, Whidby's Island, associated with remains of the *Mastodon*, a tradition of the existence of which animal still lingers among the Indian tribes. (See the author in MM. Lartet and Christy's "Reliquiæ Aquitanicæ," Part VI.) This lignite is in small quantity, and quite worthless for fuel. The whole coast of Vancouver Island on the east coast, north of Chemainos, is bounded by a belt of Carboniferous strata, composed of sandstone, shale, and coarse gravelstone conglomerates, interstratified with which are bed-of coal of a much superior character to any hitherto described. These beds from the contained fossils appear to be Cretaceous. Everywhere the strata named form a characteristic accompaniment of the coal (especially this coarse conglomerate), and nearly everywhere it is underlain by one or more seams of coal cropping out at some point on the circuit named, though it may reasonably be supposed yet to be found on the opposite shores of British Columbia. Outcrops are seen on some of the coast-lying islands, &c.; but it is only at Nanaimo where it is wrought to any extent, this being the only mine in Vancouver Island (or in the British North Pacific territories) exporting coal. Here is a village of 500 inhabitants and some fifty miners. Last year the company exported 43,778 tons. The coal is bright, tolerably hard, and not unlike some of the best qualities of English coal. It is used all along the coast for steaming and domestic purposes. An analysis gives carbon, 66·93; hydrogen, 5·32; nitrogen, 1·02; sulphur, 2·20; oxygen, 8·70; ash, 15·83. The fossil remains were then described. North of Nanaimo, on Brown's River, immense seams of coal were discovered by Mr. Brown and party; on Salmon River the Indians report coal; at Sukwash, near Fort Rupert, coal appears; and at Koskeemo Sound, on the western shore, are extensive undeveloped fields of what will ultimately, no doubt, prove the best coal in Vancouver Island, both from its quality and easy shipment. The latter, on analysis, gave—carbon, 66·15; hydrogen, 4·70; nitrogen, 1·25; sulphur, ·80; oxygen, 13·59; ash, 13·60. Other coal-fields will no doubt be discovered as exploration proceeds, but the country is so covered with dense forests and undergrowth as to render exploration very difficult. The anthracite is found on the Queen Charlotte Islands, off the north coast of British Columbia. The beds are much broken up by faults, felspathic trap dykes, and other disturbing influences, so that to work it will always be expensive and troublesome. Still the value of the discovery is of the highest importance to the coast. The coal is associated with conglomerates, a fine hard slate (out of which the Hydah Indians carve the pipes and other ornaments so common in the European museums) and metamorphosed sandstones. From fossils recently discovered the author is induced to believe it of Palæozoic age. An analysis gave—Carbon 71·20; moisture, 5·10; volatile combustible matter, 7·27; ash, 6·43. The author concluded his paper with some account of the Coal-trade of the North Pacific.

3. "On the Trap-Dykes of Edinburgh and Neighbourhood." By George Lyon. The igneous rocks around Edinburgh have been very faithfully and accurately described by many eminent geologists, chief of whom may be mentioned the late President of the society, Mr. Charles Maclaren. Referring to the trap-dykes, which are extravasated portions of igneous or fluid matter ejected into the fissures of the rocks and filling up the rents, he stated that Mr. Maclaren, in his "Geology of Fife and the Lothians," mentions nine localities where they have been observed. In the second edition of that work other three have been added. Mr. Lyon mentioned and described other localities which had not hitherto been recorded, and a few more

which had been recently discovered. These have all been laid down and marked in the map of Edinburgh deposited with the Society. Their general directions bear north-west and south-east, and cross the strike of the strata. Some geological writers have referred them to a common centre of volcanic disturbances. His observations did not support this idea. They seemed more disposed to run parallel to each other, and were perhaps connected with lines of faults, and are the result of disturbances which fractured and fissured the crust of the earth towards the close of the Carboniferous era.

Bath Natural History and Antiquarian Field-club, March 10th, 1869.—Mr. Charles Moore, F.G.S., gave the result of his Researches in the Drift-deposits of the Bath basin. The Author alluded to the changes which had occurred during recent geological times in what have been called our everlasting hills. The drifts deposited immediately upon the upper beds of the Lower Lias had originally been derived from these hills, and from the rocks forming the edge of the basin in which they lie. A short description was then given of the geology of the district, ranging from the Carboniferous Limestone at Grammar Rocks to the Great Oolite which caps the hills around. The Author suggested the possibility that if the Secondary deposits were removed, the upturned edges of this limestone would be found much fissured and disturbed not far below our feet. Reference was here made to the great probability that a fault passed through the Bath basin, throwing down the beds on the south side about 300 feet. The Post Pliocene gravels, in which the Mammalian remains are found, were attributed to the action of fresh water, and considered to have been deposited in the valleys since the district had assumed its present physical configuration. Their source might be looked for in the higher grounds through which the streams flowed, though some of the materials have been derived from a considerable distance, as the presence of Mountain Limestone, Old Red Sandstone, and other foreign pebbles indicated.

The physical conditions and the Fauna of the Bath district during—1st, the Historic period; 2nd, the Pre-historic; 3rd, the Post-pliocene period, were then described. Of the Historic period, which he would limit to the Romano-British, or Roman times, evidence appeared in the testacea, and other remains from two Roman coffins dug up near Sydney Buildings. A list was given of the shells and other contents which had been washed in through the interstices of the lid.

Subsequent to this period of the Roman occupation there appeared to have been an interregnum, during which the city was deserted and became converted into a swamp. Evidence of this, Mr. Moore thought, might be found in the fresh water accumulations through which the foundations of the new hotel had been laid. Here, as also in sinking for the railway bridge near Twerton, a vast quantity of bones of horse, *Bos longifrons*, roe deer, sheep, goat, hog, and dog have been found. The land and fresh-water mollusca associated with these remains appeared to be identical with living species. Accounts of various sections in the neighbourhood were then given in detail, *e.g.*, Pinch's Well, Batheaston Shaft, well at the New Hotel, and the excavation in Pulteney Road, in both of which latter sections the Mammalian gravel occurred—in the former. 4ft.; in the latter, 12ft. thick; and the Larkhall and Freshford gravel-pits, with their intervening bands of fresh-water clays.

As regards the physical condition of the Bath basin antecedent to the Roman period, some 14 feet beneath the foundations of the Roman city, a stratified deposit of freshwater alluvium containing innumerable land and freshwater shells and plants, occurred. Their fine laminæ, and the perfect state of the shells, etc., bespoke a lengthened and quiescent period of accumulation. The species both of the seeds and shells, being similar to those existing at present, indicated a similar temperature. These beds Mr. Moore considered contemporaneous with the Swiss-lake-dwellings, of the stone or bronze age. In confirmation of this view the presence of the *Bos primigenius* and *Bos longifrons* in both these deposits was adduced. A list of the shells, seeds, and bones found in the Pre-historic alluvium was given. The bones were similar to the others, with the addition of those of the *Bos antiquus*. The presence of hazel-nuts, seeds, fossils, and fragments of coal found in the deposit from the Bath water was accounted for by the water, as it welled to the surface, coming in contact with the drift which contains these things. The extent of these drifts, their source and material, were next described. Though the mollusca were so abundant in the marls immediately above, yet few were found in the gravel itself, and the Mammalia must have been washed or have rolled down during inundations. In the Larkhall gravel-pits, a thick bed of laminated marl divides the beds; this showed a period of repose; its contents consisted chiefly of remains from the Fullers'-earth, and likewise enormous quantities of land-shells (*Pupa marginata*), which were probably brought down with the marls from the adjacent hills. The Mammalian bones occurred near the base of the lower bed, and were *Elephas primigenius*, *E. antiquus*, *Rhinoceros tichorhinus*, *Ovibos moschatus*, *Sus scrofa ferox*, *Equus caballus*, *Bos primigenius*, and *Reindeer*. During the time of the deposit of 60 feet only of these clays and gravels in the old river courses, the presence of these bones indicated that the Mammalia, which are now extinct or have migrated to other latitudes, and with which man was without much doubt contemporaneous, both lived and died. Immediately preceding the deposit of these gravels the Glacial epoch was drawing to its close, and great climatal changes took place. The evidence of a Glacial period, though not preserved on the soft rocks of the neighbourhood, might, Mr. Moore thought, be traced in the stiff Liassic clays on which the gravel now reposes, for wherever these clays are exposed, deep and long continued furrows are visible, now filled up with the trail or drift, marking the spot where icebergs had stranded. In conclusion, Mr. Moore thought man's advent must be put back to a greatly extended period, and, according to the speculations of the mathematician and astronomer (reference was here made to Mr. Croll's calculations), at the lowest estimate, the extinct Mammalia, and some of the beds in the Bath basin in which they are found, must be from 80,000 to 240,000 years old. H.H.W.

MIDLAND SCIENTIFIC ASSOCIATION.—A meeting of this Association was held on April 26th, at the Bank House, Burton-on-Trent.

1. Mr. F. Drake exhibited and gave a short account of some human bones, consisting of a skull and some other portions of the skeletons, which he had obtained from a gravel pit at Hinckley, near Leicester, at a depth of 16 feet below the surface. The remains appeared of considerable antiquity, but there were not sufficient data given by which to assign any definite age to them. The drift gravels of the Trent have been subjected to considerable disturbance, and it was stated that tobacco pipes had been found at a depth of six or seven feet in the Trent Valley.

2. Mr. James Plant read a paper "On the so-called Pseudomorphous Crystals of Chloride of Sodium, found in the Upper Triassic rocks of Leicestershire and the adjoining counties." Mr. Plant gave Bischof's definition of the term pseudomorphous, stating that it is applied to such minerals as possess geometrical forms foreign to themselves, and acquired in a way entirely different from crystallization. They are divided into two classes: first, alterative-pseudomorphs, produced either by removal, addition, or exchange of constituents; second, displacement-pseudomorphs, produced by incrustation or by replacement. But the pseudomorphs found in the Triassic rocks belong to neither of these classes; they are produced by a deposition of substances in cavities left in rocks by the solution of imbedded crystals, analogous to casting in a mould, thus, though the outside of the cast assumes all the minute appearance of a crystal, the inside possesses none of the properties of a true crystal, having no cleavage planes, axes, etc. Mr. Plant then stated that the pseudomorphs illustrating his paper were first found near to the Spinney Hills, east of Leicester, in a thin yet persistent band of grey sandstone, varying in thickness from six inches to as many feet; they are likewise found in shales, with fine partings of greenish marl, and at these partings sticking at all angles in the sandstone and projecting into the marl are the pseudomorphs. This thin seam of sandstone is not far from the edge of the Lower Lias, and lies above the Gypsum bed, and must not be confounded with the Upper Keuper sandstone, which lies below the Gypsum. This bed of thin sandstone, with its accompanying pseudomorphs, occurs near Elton, overlying the Gypsum, and close to the edge of the Lias; here the salt casts were found associated with iron pyrites, the pyrites being incrusted upon them. At Orton-on-the-Hill, the pseudomorphs are found in the Upper Keuper sandstone before mentioned,—in this locality it is a hard rock, varying from eight to twelve feet in thickness; some of its beds are covered with ripple marks, and in the ripple marks the casts occur as simple square figures having no relief. Mr. Plant obtained his finest pseudomorphs in the Upper Keuper sandstone at Chilwell,

near Beeston, where they occurred of all sizes, from ⅛ to ⅓ an inch on the face of the cube, these specimens showed very decidedly the concave-shaped character of the crystals of chloride of sodium. In a small cutting near Beaumanor Park, pseudomorphs were also found; these in common with all others found near the edge of Charnwood Forest, are imperfect and irregular. Mr. Plant had searched the Upper Keuper beds on the west side of the river valley near Leicester for pseudomorphs without success; and gave a description of the rocks, which have a total thickness where fully developed, of about 90 feet. Mr. Plant next discussed the origin of these pseudomorphs. Hugh Strickland was apparently the first to notice them, and considered them to have been the cavities of pre-existing crystals, filled with sand, poured in from above. That the crystals were chloride of sodium and not iron pyrites Mr. Plant considered established by the fact that the time required for the formation and removal of the latter mineral would be too great; whereas it is evident that the process of formation and removal must have taken place in the interval between the deposition of the lower bed of sand and that of the one immediately above. A sandy marsh, covered by the sea at spring tides would supply the requisite conditions. Between the tides the sea-water covering such a marsh would evaporate and deposit the crystals of salt, which would then be enveloped by the fine sediment, the returning sea-water would again dissolve the crystals, leaving cubical cavities in the mud which contained them, and these cavities would be filled with a fresh deposit of fine sand brought by the tide, whilst the same sand would form a homogeneous stratum immediately above. This explanation, however, will hardly suit those cases in which the casts are formed projecting from the upper surface of the slabs of sandstone into the green marl above. Perhaps the crystal in such instances may have been formed between the sand and the mud, and when dissolved the soft cast pressed upwards. Mr. Plant alluded to the discovery of pseudomorphs in other parts of England, and in Germany, and America, and mentioned Mr. W. W. Smyth's important observations that the materials of which the casts are constituted vary with the composition of the adjacent rocks.—Mr. Stevenson thought that the formation of pseudomorphs might be going on now, for although there is no salt near Nottingham, yet, in boring, saline springs are met with.—Mr. E. Brown agreed with the author that they were formed at the time of the deposition of the beds, as it would be difficult otherwise to account for the filling up of the hollows with homogeneous matter at a latter period.

3. Mr. W. Molyneux exhibited an interesting series of organic remains, teeth, scales, and spines of fish, and shells from the Ashby coal field, and gave a short account of them. He enumerated no fewer than 19 genera of fish occurring in the Kilburn coal shales at Bretby.

4. Mr. H. T. Brown on "The absorption of carbonic acid by metallic copper." The author first called attention to Prof. Graham's *experiments*, which show that certain metals heated to redness in an

atmosphere of hydrogen retain on cooling a portion of that gas so obstinately that mere exposure in vacuo will not liberate it, but the separation may be effected by heat. In such a case the force holding the molecules of gas and metal together differs essentially from cohesion. Mr. Graham also found that Platinum and Palladium absorb hydrogen in a high degree; Palladium taking up 963 times its own volume. The Palladium is then found to have the properties of an alloy, confirming the belief in the metallic nature of hydrogen. This power of occlusion, as it is called, of a gas by a metal is also seen in the case of iron, which condenses both hydrogen and carbonic oxide. Mr. Brown then stated that he had discovered by experiment that metallic copper possesses a somewhat similar property. In this case the gas most readily absorbed, being carbonic, it is occluded at ordinary temperatures, and cannot be due to the formation of an alloy. The copper used was exposed in the form of a thin, clean, spiral ribbon, in a glass tube, in an atmosphere of perfectly dry carbonic acid, which has no chemical action upon copper. After a while a vacuum was made in the tube by means of Sprengel's mercurial pump. Heat was applied, the gases evolved measured and analysed; the whole of the absorbed gas was evolved at a temperature a little above 100° C. The amounts absorbed were variable, the largest amount being about 3-10 of the bulk of the copper used. This absorption took place in 18 hours, at a temperature of 17° C. When freshly reduced copper was exposed to the air but for three or four minutes, traces of gas were given off on heating in vacuo. It was found that copper reduced from the black oxide was capable of occluding larger quantities of carbonic acid than the metal in an ordinary state. In the experiments the total quantity evolved was almost equal to the bulk of copper used; rather more than 1-3 was evolved at a little over 100° C.; at 600 C. a partial re-absorption took place, about 1-6 of the total volume evolved; the whole was evolved at about 1,000° C. Why part of the gas should thus be given off at one temperature, and the remainder at another, and why part should be re-absorbed, the author could not explain. He considered the absorption of carbonic acid by copper to be a true case of occlusion, and not one of surface cohesion only, nor can it be chemical. Hydrogen and nitrogen were also found to be occluded in small quantities.

5. Mr. E. Brown read the last paper on "The Waste of Rock-masses by Solution," pointing out that amongst the various subærial agencies by which the present surface of the country had been shaped, the chemical solution of various beds, especially of Chalk and Limestone, has been and still is one of the most active. He remarked that the disappearance of the rainfall in the limestone district of Derbyshire without the formation of streamlets proves that the numerous fissures carrying the rain away are kept open by the solution of their sides. The caverns at Castleton and Buxton are underground rivers, and these channels are hourly increasing in size, whilst the exposed cliffs are reduced by every shower. The quaintly shaped stones used for artificial rock-work at Buxton are fragments

of lime rock of a peculiarly pure composition, which have been partially dissolved underneath the thin covering of turf which overlies the quarries whence they were obtained. At one quarry near Buxton, where a large surface has been bared, the appearance of these stones has given rise to the belief that the surface so bared has been formed by the waves of the sea, and is, in fact, an old sea-beach. This appearance, however, is simply due to modern waste by solution. The author in a lengthy paper pointed out the alterations of surface from the underground waste of Gypsum beds, and also from the solution of the matrix of gritstone rocks. It was suggested in discussion that some of the recent earthquakes might have been due to subsidence arising from underground waste.

CORRESPONDENCE.

THE *PHOLAS*-BORING CONTROVERSY.

It would appear from a statement lately made by Mr. Binney, F.R.S., of Manchester, that Mr. C. P. Jopling, in 1843, brought forward the existence of what he believed to be burrows of "lithophagæ" at a height of about 200 feet above the sea, in Furness, as a proof of a comparatively recent submergence of the land. He referred to the immense boulders on Stainton Green, on one of which I have lately found a deep curvilinear groove, in some parts polished and lithodomized. The large specimen I sent to the Geological Society was from an altitude above the sea of about 200 feet; but some of the small specimens showing a disregard of lithological composition and structure, were from a higher level, and the paper[1] referred partly to instances upwards of 600 feet above the sea. After a prolonged search, I could find none on the summits, or very near to the summits of hills, and nearly all of them were in positions to which rain could not have direct access. In some specimens the holes were bored obliquely into each other, so as to give rise to the appearance of bifurcations; but, generally speaking, they were exactly of the same form with those found by Mr. Pengelly in Devonshire, and with specimens I afterwards found in Devonshire, and described in the Geological Magazine, Vol. IV., *July*, 1867. In Vol. IV. *April*, 1867, p. 189, you expressed your belief that Mr. Pengelly's specimens agreed *perfectly* with specimens in the late Dr. S. P. Woodward's cabinet, which contained the valves of Pholas within the cavity. I should like to see the subject fully discussed in your Magazine. I hope your correspondents will perceive that the question is *not* whether atmospheric action is capable of producing holes in limestone (for this all will readily admit), but whether it can give rise to the precise form of hole requiring explanation. The advocates of the atmospheric theory ought to bring forward specimens of holes exactly agreeing with the alleged *Pholas*-borings, from walls of buildings, or from quarries, where the *commencement* of atmospheric action can be traced.

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[1] See Reports of the Proceedings of the Geological Society in the June number of this Magazine, p. 282.

MANCHESTER, *31st May*, 1869. D. MACKINTOSH.

TEETH OF *CLIMAXODUS*, FROM THE COAL MEASURES.

SIR,—I again venture to trouble you with a few remarks on the rare Coal-measure fish *Climaxodus*, about which, so far as I have been able to ascertain, nothing whatever is known beyond the fact of its having possessed teeth of a very peculiar form.

On page 496 of the GEOLOGICAL MAGAZINE (November, 1868), there appears a figure of the first specimen of *Climaxodus* discovered by me in the shale of Newsham Colliery, Northumberland, and at page 42 (January, 1869), reference is made to three additional specimens from the same Colliery. Since those communications appeared I have found four specimens of *Climaxodus*, three of which closely resemble the figure just referred to, but one appears sufficiently destinctive in its form to justify its being erected into a new species. In size it very closely resembles that which I named *Climaxodus ovatus*, but in its general outline, and especially in the ridges which traverse its surface, it is remarkably unlike any specimen I have previously found or examined. I propose for it the specific name *vermiformis*, as descriptive of its leading peculiarity, viz. the possession of vermiform ridges across its surface. *Climaxodus vermiformis*, is from the Low Main Coal Shale, Newsham Colliery, Northumberland.

General character: Tooth longer than wide, gradually narrowing towards the posterior extremity, the crown crossed by vermiform, irregularly bent, transverse ridges at right angles to its length; the surface somewhat rough and granular.

Climaxodus vermiformis, sp. nov. The specimen is nearly perfect, a fragment of the posterior extremity being absent; the length of the specimen is six-eighths of an inch, the width at the broadest part is also six-eighths, and the narrow posterior end is four-eighths of an inch wide; the crown is crossed by three very irregular vermiform ridges, the second ridge being excessively bent, at one part of its course it approaches the first ridge within one-sixteenth of an inch, and at another part it is four-sixteenths of an inch from it; the third ridge is imperfect, but the portion that remains indicates that it also crossed the crown of the tooth in a tortuous manner, the crests of the ridges on the crown of the tooth are nearly on the same level, and the spaces between each ridge are deeply concave; the surface of the bone forming the tooth, when seen by means of a microscope, presents a shimmering lustre, although the tooth, when examined by the naked eye, appears perfectly black. The tooth is attached to a thin plate of bone, and the curve of the plate supporting the tooth is sigmoidal and resembles that of *Climaxodus ovatus*, a specimen of which may seen in the British Museum by anyone who is desirous of an acquaintance with the teeth of this obscure Carboniferous fish. T. P. BARKAS.

NEWCASTLE-ON-TYNE, *June 11th*, 1869.

ON THE RELATION OF THE PORPHYRY SERIES TO THE SKIDDAW SLATES IN THE LAKE DISTRICT.

SIR,—In the GEOLOGICAL MAGAZINE for February last, there is a paper by Mr. J. R. Dakyns on a supposed unconformity of the Porphyry series on the Skiddaw Slates. When I read the paper I doubted very much the correctness of Mr. Dakyn's observations, and since then I have, along with my colleague (Mr. J. C. Ward, who is now surveying that part for the Government Geological Survey), examined the line of junction between the Porphyry series and Skiddaw Slates from Derwentwater to Warnscales Bottom, Buttermere, and we found that throughout the entire distance the two formations are brought against each other by faults of considerable magnitude. I cannot enter into details, which must be reserved for the Geological Survey Memoirs of that country. It is possible there may be an unconformity between the two series of beds, but the evidence of it must be sought for elsewhere than in the district described by Mr. Dakyns.

In reference to an additional Note by Mr. Dakyns on the same subject in the March number, I beg to say there is "a fault with an enormous throw" along Derwentwater.—I am, Sir, your obedient servant,

W. TALBOT AVELINE.

GEOLOGICAL SURVEY OF ENGLAND AND WALES,
KENDAL, *June 28th*, 1869.

ON MR. MURPHY'S THEORY OF THE CAUSE OF THE GLACIAL CLIMATE.

SIR,—In the GEOL. MAG., July 1, p. 331, you report at the meeting of the Geological Society, June 9th, a paper by J. J. Murphy, Esq., F.G.S., "On the Nature and Cause of the Glacial Climate." It is stated that he agrees with me as to the Cause of Glacial Climate except in one instance. "He maintained in opposition to Mr. Croll that the glaciated hemisphere must be that in which the *summer* occurs *in aphelion* during the greatest eccentricity of the earth's orbit. He shewed that a cool summer had more to do with the prevalence of glacial conditions than a cold winter, and referred to several phenomena furnishing arguments in favour of his opinion."

I fear that Mr. Murphy must be resting his theory on the mistaken idea that a summer in aphelion ought to melt less snow and ice than one in perihelion. It is quite true that the longer summer in aphelion—other things being equal—is colder than the shorter one in perihelion, but the quantity of heat received from the sun is the same in both cases. Consequently the quantity of snow and ice melted ought also to be the same; for the amount melted is in proportion to the quantity of energy in the form of heat received.

It is true that with us at present less snow and ice are melted during a cold summer than during a warm one. But this is not a case in point, for during a cold summer we have less heat than during a warm summer, the length of both being the same. The coldness of the summers in this case is owing chiefly to a portion of the heat which we ought to receive from the sun being cut off by some obstructing cause.

The reason why we have so little snow, and consequently so little ice, in temperate regions, is not, as Mr. Murphy seems to suppose, that the heat of summer melts it all, but that there is so little to melt. And the reason why we have so little to melt is that, owing to the warmth of our winters, we have generally rain instead of snow. But if you increase the eccentricity very much, and place the winter in perihelion, we should probably have no snow whatever, and it would then, in so far as glaciation is concerned, matter very little what sort of summer we had.

But it is not correct to say that the perihelion summer of the glacial epoch must have been hot. There are physical reasons which go to prove that, notwithstanding the nearness of the sun at that season, the temperature would seldom if ever rise much above the freezing point. See Philosophical Magazine for August, 1864, pp. 134, 135; February, 1867, pp. 125, 126. JAMES CROLL.

EDINBURGH, *July 8th*, 1869.

DINORNIS AN AUSTRALIAN GENUS.

SIR,—It will be interesting to your readers to know, that evidence has at length been discovered of the former existence in Continental Australia of birds of the Pleistocène New Zealand genus *Dinornis.*

A short time since a well was dug in that part of the Peak Downs in Queensland (about lat. 22° 40′ S.) between Lord's Table Mountain and the heads of Theresa Creek, near the track from Clermont to Broad Sound.

The well passed through 30 feet of black trappean alluvial soil, so common in Australia, which rested on 150 feet of drift pebbles and boulders, on one of which (at that depth) rested a short thick femur, so filled in with mineral matter (calc spar and iron pyrites) as to give the internal structure more the appearance of a reptilian than an ornithic bone. I have never yet seen any bone in Australia so much mineralised and yet retaining its distinctive osseous features. When placed in my hands it had been already broken in two, just as a bird's bone would be likely to break. But besides this there are two crushed-in fractures of ancient date, which have broken in the surface of the bone, and if not made in the life time of the bird, were probably made by the violence of the heavy drift in which it was found.

I had an opportunity of comparing it hastily at the Australian Museum in company of Mr. Gerard Krefft, our able Curator, and was convinced of its being a bird bone allied to *Dinornis*, to which opinion I was afterwards led by reference to the writings of Professor Owen. Since then Mr. Krefft has compared it with a collection sent over from New Zealand by Dr. Haast, and has been enabled to determine it to be a bone belonging to *Dinornis.*

I take advantage of the departure of the mail to-morrow to announce this fact, waiting for a further account of the specimen from Mr. Krefft.

The Peak Downs were discovered by Leichhardt in his famous expedition to Port Essington in 1845.

Since then the district has been traversed by Mr. Gregory, to whose journal as well as to that of Leichhardt your readers are referred. The Peak Downs are now settled, and a considerable population have been digging gold on Theresa Creek and in other places, and mining for copper has made advances to the westward at Mount Drummond.

Some time ago my attention was invited to a statement made by the Gold Commissioner there, to the effect that a "*Tertiary River*" had been discovered, and I was requested to examine the facts alleged. On breaking up a vast amount of the pebbles and boulders said to have been found in this "Tertiary River," I discovered that there was no clear evidence of anything that could be called Tertiary; but that they were pebbles of probably Quaternary accumulation, consisting of Silurian, Carboniferous, and Secondary rocks with the igneous rocks of the neighbourhood, which latter may be in part of Tertiary age.

In some of the creeks running more to the south-eastward from the Peak Downs, and like Theresa Creek, belonging to the Mackenzie River system (*e.g.*, Crinum Creek), occur bones of *Trionyx* and *Crocodile*. A year or two ago I forwarded some of these to my friend Professor Huxley, whose determination I have not yet received.

The naked fact of the discovery of *Dinornis* in this country is of some value as to Geological inferences.

I may add, in conclusion, that I look forward to further discoveries in the vast accumulations of drift that encumber some of the localities in the neighbourhood of the rivers watering the Leichhardt district, where, among other relics, are those of the Carboniferous formation which now presents only the wreck of a mass of strata that once must have been nearly continuous over an area comprising several degrees of latitude and longitude on one side or other of the Tropic of Capricorn.

W. B. Clarke, F.G.S.

St. Leonard's, New South Wales,
19*th May*, 1869.

P.S.—I have omitted to mention, that in the collection I exhibited at Paris in 1855, No. 49 consisted of *Osseous breccia* (Bird bones) from the Coadrigbee Cavern, in New South Wales. So, *Dinornis*, though new, is not the first of its order.

THE SO-CALLED HYOID PLATE OF *ASTEROLEPIS*.

Sir,—It may gratify the workers in the Old Red Sandstone to learn that I have solved the puzzle of the so-called Hyoid plate of *Asterolepis*. It is in reality a Dorsal plate fitting on immediately behind the "Cranial Buckler" in nearly the same position as that occupied by the Dorsal plate of the *Coccosteus*. I have succeeded in obtaining two fine specimens of the head of the *Asterolepis* with these plates in their proper positions, from the Great Flag Deposits of Caithness, and I hope to be able to lay them before the Geological Society of London in the course of the next winter.

John Miller.

27, Bloomsbury Street, Bedford Square,
London, 10*th July*, 1869.

THE

GEOLOGICAL MAGAZINE.

No. LXIII.—SEPTEMBER, 1869.

ORIGINAL ARTICLES.

I.—The Freshwater Deposits of the Valley of the Lea near Walthamstow, Essex.

By the Editor.

OWING to the great increase of the population of the Eastern parts of London, the East London Water Works Company have been engaged for several years past, in constructing most extensive Reservoirs for the storing and filtering of Water.

These Reservoirs commence near the Lea-Bridge road, and extend thence in a northerly direction beyond the Tottenham Railway Station, and occupy a large tract of the Lea Valley, known as the Walthamstow Marshes.

About a quarter of a mile from the Great Eastern Railway at Tottenham, between the Mills and Higham Hill, two large Reservoirs are now in process of excavation, covering together more than one hundred acres.

The depth penetrated over the whole area of the floor of the Reservoirs probably nowhere exceeds, on an average, 10 feet, but the trenches made for the "puddle-walls" in the centre of the artificial embankments which enclose the Reservoirs, go down to a depth of 20–24 feet.

The materials removed are all of Post-Tertiary age, and consist of surface-soil, loamy clay, peat, shell-marl, coarse and fine sands, rounded and sub-angular gravels from the Chalk and Woolwich series, with pebbles of chert and sandstone from the older rocks.

The beds above the gravel which forms the floor of the Reservoirs, vary in thickness and extent over the whole area. Thus, the shell-marl or deposit consisting of a vast accumulation of Land and Freshwater shells (the species of which are hereafter noticed), varies in thickness from two inches to three feet, and occupies basins or depressions in the underlying clay or gravel beds.

Amongst the varied sections presented during the progress of the works, the following will illustrate the order of succession of the deposits cut through.

Section No. 1 at South-East corner of Eastern Reservoir :—

No. 1.	Surface soil	12 inches.
„ 2.	Clayey loam	18 „
„ 3.	White shell-marl	10 „
„ 4.	White-coated sub-angular gravel, encrusted with lime from superimposed shell-marl...	18 „
„ 5.	Rounded and sub-angular gravel, stained with oxide of iron (actual depth not ascertained).	

This gravel (No. 5), which forms the floor of the Reservoir, is of very considerable thickness. At one spot, where pumping for "puddling" had been going on, a hole, more than 10 feet in depth from the surface of the gravel-bed, still showed the same gravel with abundance of water.

Section No. 2 at South-west corner of Western Reservoir :—

No. 1.	Vegetable Mould	12 inches.
„ 2.	Stiff brown Clay	24 „
„ 3.	Shell-marl and Marly Clay	12 to 36 „
„ 4.	Stiff dark clay with wood	18 „
„ 5.	Peat lying on ...	24 „
„ 6.	Thin band of black gravel stained by overlying peat	3 „
„ 7.	Clean red gravel (corresponding with Bed 5 of Section No. 1, and forming the floor of the Reservoir).	

Section No. 3 in the Eastern Reservoir, and near the Embankment between Eastern and Western Reservoirs :—

No. 1.	Surface-soil	18 inches.
„ 2.	Stiff Clayey Loam ...	18 „
„ 3.	Very compact black Peat	3 feet.
„ 4.	Shell-marl	12 inches.
„ 5.	White-coated sub-angular Gravel...	12 „
„ 6.	Clean red Gravel forming floor of Reservoir, equivalent to bed 5 of section No. 1 (depth not ascertained).	

The beds above the shell-marl (and, in some parts of the area, those also below it), contain abundant remains of forest vegetation. Large areas of the upper loamy and peaty beds, where exposed in the course of the works by the removal of the more superficial layers, exhibiting the ancient remains of trees with their spreading roots still in situ, but in most instances converted into lignite and coated with bog-iron-ore. Hazel nuts are abundant, and we were able to detect evidence of the Oak and the Alder, but there are no doubt several other trees which may be determined by their wood upon further examination under the microscope.

The peat, especially near the centre of the works (section No. 3), attains a thickness of more than three feet, and is exceedingly stiff and compact when first cut through, but from exposure it rapidly dries and cracks vertically into irregular prismatic masses, which may be readily detached.

The Shell-bed, on the Eastern and Northern sides of the area exposed, exhibited many cases of oblique lamination, indicative of currents and a winding rivercourse. Most of the bivalve shells have their valves united, and the *Uniones* reposing in their natural position as in life, whilst the operculum remains in the aperture of many of the *Paludinidæ*.

An examination of a small quantity of the materials composing the the Shell-marl, yielded the following species of Land and Freshwater shells.

Helix hortensis, Müller.
—— *nemoralis*, Linn.
—— *arbustorum*, Linn.
—— *ericetorum*, Müll.
—— *caperata*, Montf.
—— *hispida*, Linn.
Succinea putris, Linn.
Zua lubrica, Müll.
Clausilia bidens, Müll.
Limnea stagnalis, Linn.
—— *peregra*, Müll., sp.
—— *auricularia*, Linn., sp.
—— *palustris*, Linn., sp.
Limnea truncatula, Müll., sp.
Planorbis corneus, Linn., sp.
—— *carinatus*, Müll., sp.
—— *vortex*, Linn., sp.
Ancylus fluviatilis, Müll., sp.
Valvata piscinalis, Müll.
Bithinia tentaculata, Linn.
—— *ventricosa*, Gray.
Neritina fluviatilis, Linn.
Unio tumidus, Retz.
—— *pictorum*, Linn.
Pisidium amnicum, Müll.
Cyclas cornea, Linn.

From the Peat and Shell-marl, the following Mammalia, etc., have been identified, viz. :—

	Nature and Relative Abundance, etc.
Man.	By his Osseous remains and implements, in stone, bone, bronze, and iron.[1]
Canis lupus, Linn.	Common.
Vulpes vulgaris, Briss.	Not common.
Castor Europæus, Owen.	Several examples.
Equus caballus, Linn.	Abundant.
Sus scrofa, Linn.	,,
Cervus elaphus,[2] Linn.	,, of all ages.
Cervus capreolus, Linn.	Not common.
Cervus dama, Linn.	One antler (probably recent).
—— *tarandus*, Linn.	Antlers—rare.
Alces palmatus[3] (*Cervus alces*), Linn.	Rare.
Capra hircus, Linn.	Abundant; many skulls of kids.
Bos primigenius, Boj.	Not common.
— *longifrons*, Owen.	Common.
— *frontosus*? Nilss.	Rare.
Aves.	
Haliætus pelagicus	(Tibia) rare.
Sp.	A few bones.
Pisces.	
Sp. (*Vertebræ*, etc.)	Rare.

From the lower beds reached in excavating for the "puddle-wall:"

Elephas primigenius, Blum.	Portions of tusk and molar tooth.
Bos primigenius, Bojanus.	Head and horn-cores.
Cervus strongyloceros, Owen.	Base of a gigantic antler.

Mr. A. W. Franks, F.S.A., Keeper of the Ethnographical Department, and of the "Christy Museum," kindly informs me that he has examined and identified the following works of human industry, obtained from Walthamstow, most of which are now in his possession, viz., two bronze spear-heads, one bronze arrow-head, one bronze knife, one iron sword (late Celtic), part of the bronze sheath of a "late Celtic" dagger, part of a Kimmeridge coal armlet, a pierced axe-head of stag's-horn, a bone knife, a stag's-horn club, various "late Celtic" earthen pots, some hand-made, and some probably turned on a wheel, etc., etc.

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[1] Of the relative depth at which these various works of human industry were actually obtained, only a rough estimate can be formed, as they have, in almost every case, been obtained by Mr. Joseph Wood (the well-known collector of Bradford Clay Fossils) from the Navvies employed in the excavation. The writer was so fortunate as to obtain on the East side of the Eastern Reservoir a Flint Scraper, which he extracted with his own hands in undisturbed matrix from the bed of dark loamy clay, three feet below the surface.

[2] Having the antlers and ends of the tynes in many instances cut previous to their having been imbedded.

[3] See description of remains by Professor Owen, p. 389.

In tracing back the history of this locality, it is exceedingly difficult to ascertain any very exact data. But this much is certain, that so late as A.D. 1700, the entire tract between the Rivers Roding and Lea was forest-land, the greater part covered with timber.

In the Notes to Bowen's Map of Essex (1743), it is stated "Epping forest was formerly of very large extent, but its limits were settled and restrained by Act of Parliament (17 Car. I.), according to which regulation, it is now about 14 miles long and 10 broad. Tis full of game, and well stocked with deer, said to be the largest and fattest in the kingdom."

According to the records of the time of Henry III. (1228), and Edward I. (1298 and 1300), the whole County of Essex was at that time one entire Forest.

There is little doubt that Henhault, Epping, Walthamstow, Tottenham, Enfield, and Edmonton, were, at no very remote period, one continuous tract of Forest land. In the reign of Henry II. (1154), the Forest of Middlesex extended from Houndsditch, to about 12 miles north of London, and belonged to the Corporation of the City. The Forest is described as abounding in wolves, wild boars, stags, and wild bulls. So late as the time of Henry VI. (1485), wolves were met with there.

This tract was not disafforested until 1777 (17 Geo. III., c. 17).

Chapman and Andre's Map of Essex (1777) is the earliest accurate map of this county, and shows at least a portion of the tract under consideration, still covered with Forest trees, and styled Walthamstow Forest. Indeed, so late as the first Ordnance Survey Map (published in 1805), the "Lower Forest," extended close to Maryland Point, Stratford.

In referring to these records of the former continuity and extent of Epping and Walthamstow Forests, I do so, not to explain away the undoubted antiquity of these buried remains, but rather to show that their quiet repose for so long a period at so comparatively trifling a distance beneath the surface soil, is in all probability due to the fact that the spot where they occur has not been disafforested 100 years, and has never been disturbed by agriculture, but used simply as pasturage.

Note.—From the broad tract of the Lea Valley occupied by the Freshwater Shell-bed, and also from the abundance of Drift-wood, together with remains of the Beaver, it is quite possible that we may have here preserved to us the evidences of an old forest-tract flooded by Beaver dams, a condition of things which is sure to arise wherever the Beaver makes his habitation.—See "The American Beaver and his Works," by Lewis H. Morgan, Philadelphia, 1868.

II.—NOTE ON THE OCCURRENCE OF REMAINS OF THE ELK (*ALCES PALMATUS*) IN BRITISH POST-TERTIARY DEPOSITS.

By Professor OWEN, F.R.S.

AT the date of publication of my "British Fossil Mammals" (1846) I had not obtained satisfactory evidence of the Elk as one of them. But shortly after that period the Tyne-side Naturalists recorded in their instructive 'Transactions' the discovery of a fine antler of an Elk ('*Alces palmatus fossilis*' of the 'Club') in a Peat-bog, near the North Tyne River, Northumberland. I am now able to add to that notice evidence of the extension of the localities of true Elk-remains as far south as Walthamstow, Essex. The excavations of the East London Waterworks, now in progress, have exposed sections of an old bed of the River Lea, near Walthamstow. In this bed, at from five to eight feet in depth, have been obtained remains of *Bos longifrons*, *Capra hircus*, with remarkably fine horn-cores, part of an antler, two feet eight inches long, of a Reindeer (*C. tarandus*), and in another kind of deposit, as evidenced by the darker colour of the bones, and a thin partial coating of limy matter, were obtained the humerus, antibrachium, and metacarpus of an Elk, closely corresponding with those of the existing Scandinavian species (*Cervus Alces*, Linn.; *Alces palmatus*; Auct., and *Alces Europæus*, Hamilton Smith).[1]

The length of the humerus is 1 foot 3 inches: the least circumference of the shaft, 4 inches 10 lines; the length of the antibrachium is 1 foot 7 inches; its least circumference, 5 inches 3 lines. The ulna is anchylosed to the radius along great part of its distal half. The metacarpus is 1 foot 9 lines in length, and 4 inches in circumference. The characters of these bones in the peculiarly long-legged kind of deer called 'Elk' or 'Moose' differentiate them readily and strongly from those of the Bovines, of the Megaceros, and of the Wapiti or other large round-antlered deer. They are, perhaps, more satisfactory evidences of *Alces* than portions of antler. Professor Gervais, *e.g.*, writes doubtfully, on such grounds, in regard to '*Cervus alces*' as a French fossil:—"Cette espèce—paraît avoir laissé des débris fossiles en France dans les terrains diluviens. M. de Christol y a rapporté quelques portions de bois extraites des sables diluviens des Riège, près Pézenas, que nous attribuerons à notre *Cervus martialis*." (Paléontologie Française, 4to. p. 80).

We owe to Julius Cæsar the valuable record of the existence of both the Reindeer (*Bos-cervus*) and the Elk (*Alces*) in the Black Forest and conterminous part of Germany at the period of his campaign in that country and in Gaul. (De Bello Gallico, Lib. vi. cap. xxvi. p. 320. Ed. Ludg. Bat. 1737).

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[1] I have not been able to discern any distinctive character of specific value between the N. American and Scandinavian Elks.

III.—On the Organic Remains found in Clay near Crofthead, Renfrewshire.

By James A. Mahony, Esq.

THE number of the Geological Magazine, for September last,[1] contained a description, by Mr. James Geikie, of stratified beds of sand and mud intercalated with Boulder-clay, which occur in the Cowdon valley, near Crofthead. His reference to some contained vegetable *débris* induced me to make an examination of the strata, which has resulted in revealing an abundance of organic remains quite exceptional in such deposits.

In the stratified beds, which are cut into to the depth of thirteen feet, there are some layers of vegetable matter. Two are specially well marked; the lower, two inches in thickness, containing numerous stems of mosses, and the upper (lying seven feet higher in the section) ten to twelve inches thick, being that in which the skull of *Bos primigenius* was found. These layers differed somewhat in the species of the organic remains, as well as in their comparative abundance, though both were rich in the relics of what must have been a varied fauna and flora. The lower two-inch bed was remarkable for the numerous stems of *Hypnum tamariscinum* which occurred through its entire mass, and the fragments of a soft-shelled Entomostracan—probably a *Daphnia*, which must have existed in myriads during the deposition of this bed. It also contained many plant-seeds; fragments of wood, birch and hazel being most frequent; three species of mosses; and eggs of an insect—one of the *Ephemeridæ*.

From the upper leaf-bed I obtained some species of Desmids—these microphytes being quite absent in the lower bed; eleven mosses; nine Phanerogams; and in the animal kingdom, representatives of Protozoa, Annelida, Crustacea, and Insecta. The bed was not equally rich in organisms through its whole extent. On separating the layers at some places, only a fragment of a reed-like plant would be visible, while other parts were crowded with mosses and leaves of the Pond-weed. Where the plants existed in greatest plenty, there the animal remains were also most abundant. The larger objects were removed from the surfaces exposed on separating the various laminæ, the remaining portion being afterwards macerated in water, when many seeds were found floating on the surface. The residue was then passed through sieves of different sizes—thus yielding an assorted series of remains which were mounted for identification.

On examining a portion of this leaf-bed under the microscope, I was gratified and surprised at finding the whole field of view crowded with frustules of *Diatoms*, many of them broken and all free from endochrome. They abounded in the twelve inch leaf-bed, forming, as nearly as I could determine, one fourth of the entire mass. In order to procure them free from extraneous matter, I steeped 2 oz. of the clay in water for a few minutes, then, with frequent stirring, poured off the water holding the lighter particles in suspension, allowed the remainder to rest for a time, when the clear supernatant liquid was removed and the residue dried and afterwards ignited for half an hour, which dissipated the organic substances present; boiled in strong hydrochloric acid, thus dissolving the alumina, iron, and lime, and leaving a white powder composed exclusively of diatoms and grains of quartz. These were separated to some degree by repeated washings, the heavier fragments of quartz subsiding rapidly and remaining behind.

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[1] Geol. Mag., Vol. V., p. 393.

In submitting a list of the species of organic remains, I may premise that a few of the names must, from the fragmentary state of the objects, be held only as indicating their possible affinities.

PLANTÆ.

DESMIDIEÆ.—*Micrasterias denticulata*, in the sporangial state. Abundant.

Staurastrum polymorphum. A single example.

Cosmarium. An empty frond.

DIATOMACEÆ.

Epithemia turgida.
,, *sorex.*
,, *gibba.*
Cymbella cuspidata.
,, *Ehrenbergii.*
Amphora ovalis.
Cocconeis placentula.
,, *pediculus.*
Cyclotella minutula.
Campylodiscus costatus.
,, *spiralis.*
Surirella biseriata.
,, *craticula.*
Cymatopleura solea.
Navicula ovalis.
Pinnularia major.

Pinnularia mesolepta.
,, *acuta.*
,, *dactylus.*
Cocconema lanceolatum.
,, *cistula.*
Odontidium mutabile.
,, *Harrisonii.*
Denticula sinuata.[1]
Gomphonema subtile.
,, *acuminatum.*
Diatoma vulgare.
Tabellaria flocculosa.
Stauroneis punctata.
,, *linearis.*
Melosira orichalcea.

MUSCI.

Leskia sericea.
Hypnum palustre.
,, *tamariscinum.*
,, *splendens.*
,, *uncinatum.*
,, *ruscifolium.*

Hypnum rivulare.
,, *cordifolium.*
Climacium dendroides.
Pogonatum nanum.
Bryum [2] ?

PHANEROGAMIA.—*Ranunculus aquatilis, Galium palustre, Pedicularis palustris.* Many seeds of these plants were found, chiefly in the upper bed.

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[1] This is the commonest form in the deposit, composing probably a fourth of the whole.

[2] This moss belongs to the subgenus *Webera* of Schimper. Texture and serratures same as *W. nutans*, but leaves somewhat broader.

Myriophyllum spicatum. Represented by a portion of the characteristic leaf.

Scirpus lacustris. In the upper bed only, where it was very abundant.

Potamogeton lucens. Leaves and seeds frequent.

Scutellaria galericulata. A leaf of an herbaceous plant most closely agrees with this species.

Betula alba. Numerous twigs of this tree were found in the lower bed, none in the upper.

Corylus Avellana. Represented by a fragment of root—also from the lower bed.

ANIMALIA.

Numerous objects were found which seemed to be the remains of infusorial life but too incomplete for identification.

SPONGIDÆ.—*Spongilla fluviatilis.* The acicular spiculæ of a fresh-water sponge were very frequently to be met with,—occurring indeed on every slide. In one instance I got a fragment of the sponge itself, with the contained spicules, which quite agree with those of *S. fluviatilis.*

ANNELIDA.—*Hæmopis sanguisorba.* Two examples of the jaws of this leech with teeth all perfect.

CRUSTACEA.—*Daphnia* ? There occurred a very complete organism, with rudimentary eyes and jointed limbs, which I consider to be a larval form of *Daphnia.* The lower bed contains thousands of fragments of clear yellowish animal tissue which, from its markings and other characters, I think are the remains of a soft-shelled *Entomostracan.*

INSECTA.—Portions of the elytra of beetles were pretty frequent. Many mandibles, etc., have been mounted by Mr. J. Coutts—the various objects indicating the presence of at least three species.

MAMMALIA.—*Bos primigenius.* A skull exhumed by the labourers and described by Mr. James Geikie.

The evidence presented to us by these stratified beds clearly suggests the existence of a lake, and the organisms that peopled its waters, or lived along its margin, have been here wonderfully preserved during a long lapse of time. The extent of this time it is difficult to determine (although the latest observations on the section tend to confirm the opinion of these beds being of Boulder-clay age), but that it dates *at least* from the close of the Glacial period is well shown from the following circumstance.

The porphyritic trap, which rises as a sloping wall at the lower end of the beds and forms their eastern boundary, is a rock easily acted on by the weather, and already, after two years exposure consequent on the removal of the clay, exhibits much disintegration. Now this rock face is highly glaciated, presenting a polished surface with deep groovings and striations which have evidently been protected from obliteration by the water of the small lake, formed soon after the disappearance of the ice, and afterwards by the beds of clay and sand deposited as the lake gradually silted up. Had the

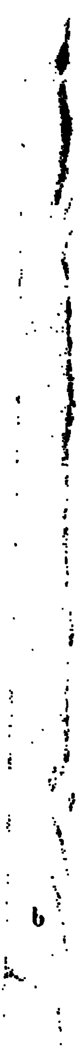


Fig. 3

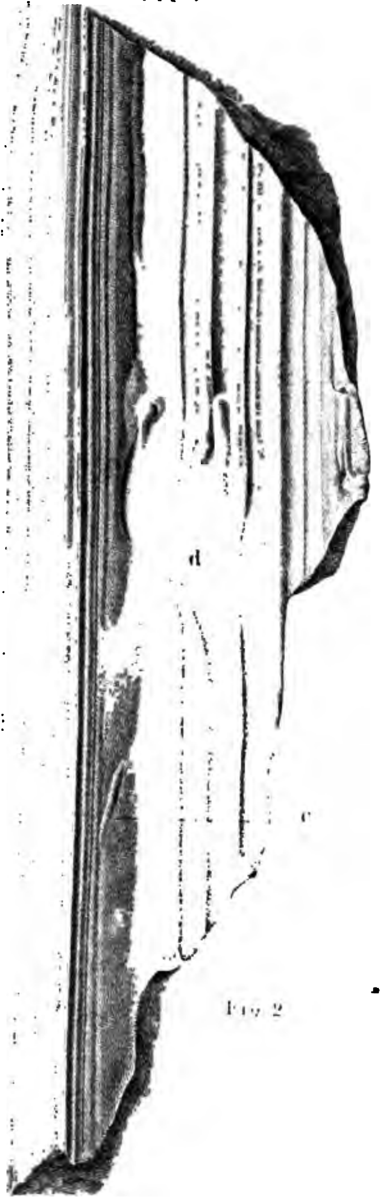


Fig. 2

Fig. 4

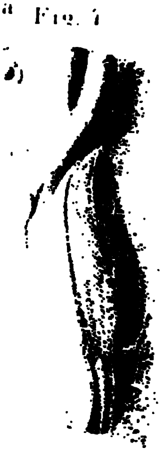
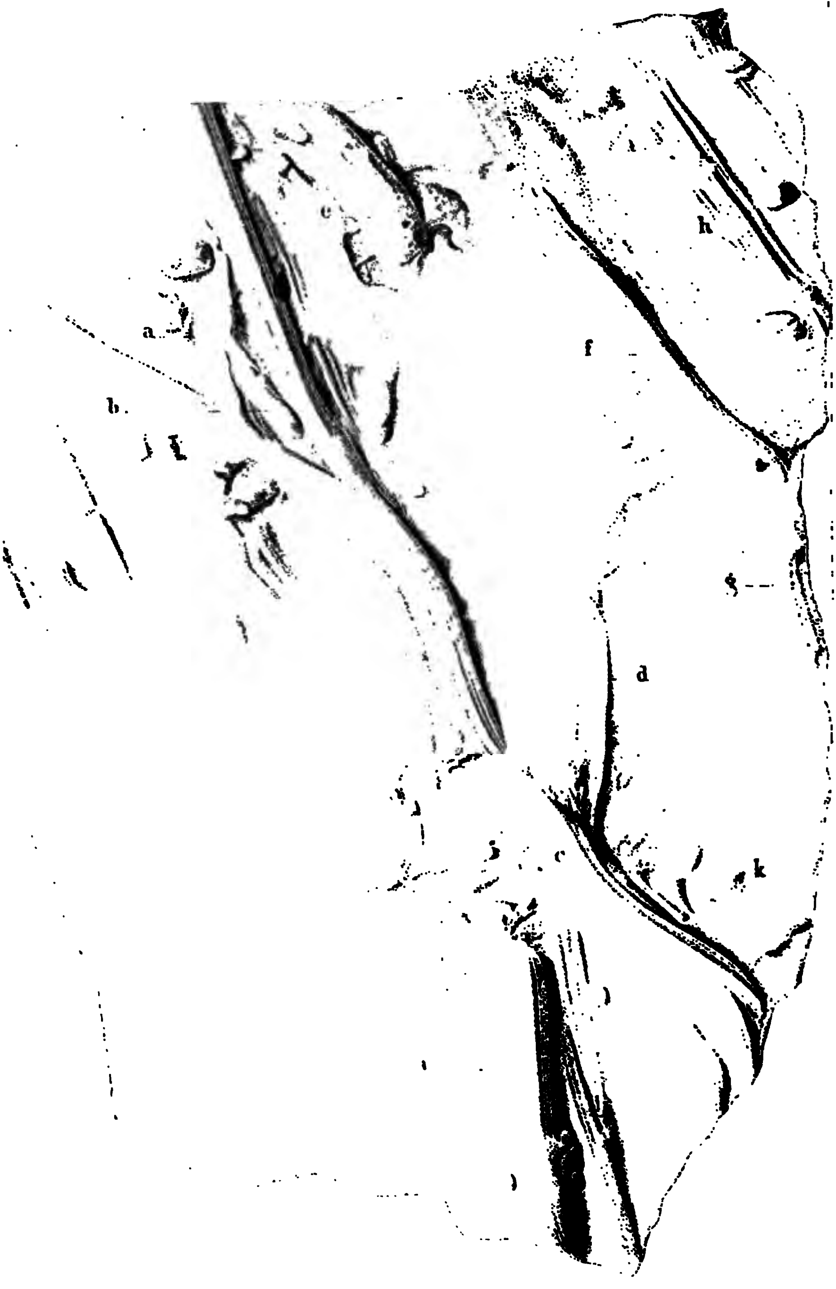


Fig. 4 a

Fig. 1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d
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b
a
B
b
a
B'
a
D
a
a
a
b
a
b

crag been exposed to the weather for a long period after the ameliorated climate set in we should not have had this interesting record of ice-action, but an undecipherable heap of rock-fragments.

The exceeding abundance of Diatomaceous remains is remarkable. In this respect the deposit is such as might, with some slight modification of external causes, be the equivalent of the famed Lough Mourne and Lough Island; Reavy strata in Ireland; the Raasay, Peterhead, and Mull beds in Scotland; and the Dolgelly earth in Wales. That they have not been detected in the English clays probably arises more from lack of examination than from any dearth of these organisms.

Note.—Mr. J. Wallace Young, of this city, has directed my attention to the presence of titanic acid in the laminated clay, as well as in some of the adjacent rocks. The proportions varied from ·94 per cent. in the clay to 2.93 per cent. in one specimen of felstone. In an examination I have just made of the upper leaf-bed I find it to contain ·80 per cent. of titanic acid.

IV.—ON SOME FOSSILS FOUND IN THE EOPHYTON SANDSTONE, AT LUGNÅS, IN SWEDEN.[1]

By J. G. O. LINNARSSON.

[Plates XI., XII., and XIII.]

NO other part of Sweden affords more favourable opportunities for studying the earliest fossiliferous deposits and their relations to each other than Vestrogothia, with its unusually complete, undisturbed, and, in many natural sections, exposed series of strata. Its two lowest principal layers, consisting of sandstone and alum-slate, are to be referred to the Cambrian system, if that system, as proposed by Sir Charles Lyell, Salter, and others, be extended over the "Primordial zone," which is easily distinguished by its organic remains from the overlying Silurian deposits. This sandstone has long been known as the oldest stratum of Vestrogothia above the Fundamental Gneiss. Traces of seaweeds were found in it by our earlier geologists, and caused it to receive the name, still commonly used, of Fucoid sandstone. Deposits of the same period are distributed over large parts of Scandinavia; and Professor Angelin, who, like his predecessors, had found them to be the oldest portion of the whole "Transition formation" of Scandinavia, included them all in his *regio Fucoidarum,* no other Fossil having as yet been found in them. Norwegian authors have proposed the denomination "Sparagmite stage," for the rock prevailing in Norway, which has not as yet afforded any fossils, a term also adopted by Professor Torell.

Until lately few additions had been made to our knowledge of the organic remains preserved in the deposits of the *regio Fucoidarum.*

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[1] Translated from the Ofversigt af Kongl. Vetenskaps Akademiens Förhandlingar, March 10, 1869.

Beside the seaweeds, Annelid burrows were found in it several years ago, but nothing was known of the existence in it of any other fossils, and it was generally assumed that very few fossils were to be expected in a layer of an age so remote, and that the rock itself was not capable of preserving, in a sufficiently distinct condition, the remains of such organisms as might have been living at the time of its deposition. Accordingly, until late years, very little attention had been directed to the Fucoid sandstone of Vestrogothia, and I had therefore no great hope of any new discoveries until I succeeded two years ago in finding a *Lingula*. Some time afterwards Professor Torell published his excellent geognostical and palæontological description of all the coeval rocks of Sweden,[1] and of the remarkable discovery made by himself and Dr. J. A. Wallin of a comparatively highly organised plant, the *Eophyton Linnæanum*, Torell, in these oldest deposits.

Since, through these important researches of Professor Torell, due attention has been drawn towards the oldest sandstone of Scandinavia, it becomes desirable to know with accuracy its age in relation to deposits in foreign countries and especially to the English formations, upon which the division into periods of the older Palæozoic time now in use has been founded. At present no certain conclusions can be drawn from the organic remains, these being still so imperfectly known. It is necessary, then, to rely chiefly on the stratification, which can be ascertained with facility and accuracy in Vestrogothia better than anywhere else. Sir R. Murchison, who places the "Primordial zone" in the Lower Silurian system, refers to that system not only the alum-slate of Vestrogothia, which apparently belongs to the Primordial zone, as defined by Barrande from its Trilobite fauna, but also its sandstone layer.[2] Agreeing with Professor Torell,[3] I believe, however, the latter to correspond with the "Longmynd group" of England, which is also considered by Sir R. Murchison as Cambrian, and, according to the classification of Sir Charles Lyell, forms the lower part of the Cambrian system of England. Like the Longmynd formation, the sandstone layer of Vestrogothia reposes on gneiss, which we have every reason to believe to be of Laurentian age. The alum-slate lying above the sandstone completely corresponds with the Lingula-flags, which in England overlie the Longmynd formation. In the alum-slate of Sweden, as in the Lingula-flags of England, two principal divisions are found, the well characterised faunas of which Professor Angelin was the first to distinguish as the *regio Conocorypharum* and *regio Olenorum*. The older of these regions, the *regio Conocorypharum*, is characterised chiefly by the genera *Paradoxides* and *Conocoryphe* (*Conocephalites*), while the genus *Olenus* appears later; thus it is distinctly equivalent to the "Lower Lingula flags" or "Menævian" group of England. The layers which lie above and below the sandstone layer of Vestrogothia being thus equivalent to those which bound the Longmynd formation, there is, at least, great probability that these deposits belong to the same period, and that the whole *regio Fucoidarum* is to be regarded as a representative of the lower part of the Cambrian system. If that be not admitted, it must be supposed that the *regio Fucoidarum* has no equivalent in England, and that Sweden is deficient of every deposit from the earlier Cambrian period. For such a supposition, however, no sufficient reason can be afforded. The occurrence of plant-remains cannot be regarded as such, at least so long as nothing corresponding has been known from the Upper Cambrian, and Brachiopods have now been found also in the Longmynd formation. As even the Longmynd formation is said to contain one or perhaps more Brachiopods common to the Lingula-flags,[1] the break between these formations cannot be very considerable, and we have thus additional reason to give to the Cambrian period a longer duration than Sir R. Murchison has assumed. This circumstance and the great dissimilarity between the faunas of the Upper and Lower Lingula-flags has induced some English writers to refer to the Lower Cambrian system not only the Longmynd group, but also the Lower Lingula-flags.[2] Accordingly the *regio Conocorypharum* should also be referred to the Lower Cambrian system. The great geognostical resemblance, however, between the *regio Conocorypharum* and the *regio Olenorum* makes it more suitable, if a tripartition of the system (into a lower, a middle, and an upper stage) be not preferred, to refer them both to the upper division, at least till some closer palæontological relation, than any hitherto shown, shall have been discovered between the former and the *regio Fucoidarum*, or between the Lower Lingula-flags and the Longmynd formation. While thus referring, with Sir Charles Lyell, both portions of the "Primordial zone," characterized by Professor Angelin, to the Upper Cambrian system, I still think that the "Tremadoc group" is to be excluded from that System, and, together with its nearest equivalent in Sweden, the *regio Ceratopygarum* of Professor Angelin, to be regarded as the lowest portion of the Lower Silurian.

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[1] Bidrag till Sparagmitetagens geognosi och palæontologi. Lund, 1868.

[2] Davidson, On the Earliest Forms of Brachiopoda, etc., GEOL. MAG. 1868.

[3] *Russia* in Europe and the Ural Mountains, Vol. i. p. 16.

The sandstone layer of Vestrogothia belongs as a whole to the *regio Fucoidarum*, but in some other parts of Scandinavia there are deposits of Sandstone also belonging to the younger Cambrian period. Thus in Norway the "Hoejfjelds Kvarts" forms a part of the primordial zone, the stage 2 of Professor Kjerulf.[3] In Oeland, at the base of the alum-slate layer, lies a "calcareous quartz-schist"[4] in which the earliest genera of Trilobites have been found, and which by reason of its fossils has been referred by Professor Angelin to his *regio Olenorum*, but which, with greater show of reason, might be referred to the *regio Conocorypharum*. In Vestrogothia the same forms occur in the lowest part of the alum-slate, to which the quartz schist of Oeland is thus equivalent.

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[1] L. c., p. 2.

[2] See Th. Belt, On the "Lingula-flags," or "Festiniog Group" of the Dolgelly District. GEOL. MAG. 1867, p. 493 *et seq.*

[3] Kjerulf, Stenriget og Fjeldlæren, p. 212.

[4] A. Sjögren, Anteckningar om Oeland. Ofversigt af K. Vet. Akad. Förhandl. 1851.

On geognostical as well as upon palæontological grounds two divisions may be distinguished in the sandstone of Vestrogothia. In the lower, which is seldom seen in any natural section, the rock is hard, usually thin-bedded; in the upper, which is in many places exposed and has chiefly given rise to the names of Fucoid sandstone and *regio Fucoidarum*, it is softer and often thick-bedded. At the very limits of the adjoining layers the sandstone is of an anomalous composition. At the limit of the gneiss it has the appearance of a conglomerate, and contains also some felspar grains. The uppermost sandstone which lies immediately beneath the lowest alum-slate contains a great deal of pyrites, and sometimes, as at Hunneberg, of clay also. These anomalous portions of the layer are very thin, being hardly more than one or two feet in thickness.

The lower parts of the sandstone, although not overlooked by earlier writers, have, owing mainly to the researches of Dr. Wallin and to Professor Torell's descriptions of the fossils collected by the former, attracted a greater degree of attention, and it was through their works that I was led to make myself acquainted with them.

The Lugnås[1] mountain offers the best opportunity of observing the lower division of the sandstone layer and its contact with the underlying gneiss, that is to say, the line of demarcation between the Cambrian and the Laurentian systems. For that reason this locality has often been visited by geologists, but their views respecting the position of the limit are very different. From the olden time millstones have been quarried on a large scale in many places at the foot of the mountain, out of a rock containing the ingredients of granite and gneiss, but in which the felspar has partially been converted into kaolin. According to some writers, this rock is a weathered granite or gneiss, and as such referred to the Laurentian system, or the "fundamental rocks;" others have believed it to be an arkose formed by the mechanical decomposition of a granitic or gneissose rock and the subsequent cementation of the components. According to this opinion it would constitute the lowest portion of the sandstone, and thus belong, together with the overlying sandstone, to the Cambrian (respectively Silurian) system, or the lowest part of the "Transition formation." Hisinger hesitates between these two opinions; sometimes he names the rock a "rotting" granite or gneiss,[2] but sometimes he says that "the millstone bed may be perhaps properly regarded as a granitic transition arkose separated from the fundamental rock or the gneiss by a thin quartzose layer."[3] Sir Roderick Murchison believes the rock to be a Silurian arkose, constituting the lowest part of the sandstone.[4] But Dr. Wallin, in his detailed and accurate description of the layers of the Lugnås mountain,[5] has clearly shown, that the millstone rock is nothing but a variety of the common gneiss of the district, caused by the partial weathering of the felspar, and by no means, as the true arkose, a sandstone-like rock. In visiting the millstone quarries of Lugnås last autumn, I felt convinced, almost at the first glance, of the truth of Dr. Wallin's determination. The mica scales are often seen to be arranged in well-marked laminæ, usually dipping almost vertically, so as to produce a more or less distinct gneissose structure. Besides this the rock (as stated by Dr. Wallin) increases in hardness downwards and resembles more and more the unchanged gneiss of the neighbourhood.

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[1] Pronounce: Lungnose.

[2] Anteckningar i Physik och Geognosi, Vol. iv. p. 48, 49 (1828).

[3] Anteckningar, Vol. v. p. 67 (1831).

[4] Russia in Europe, etc., vol i. p. 16.* Siluria, 4th ed., p. 347.

[5] *Bidrag* till kännedomen om Vestgötabergens byggnad. Lund, 1868.

Thus it is above the millstone bed, that the oldest Cambrian deposit commences. The all but horizontal sandstone overlies unconformably the nearly vertical strata of the millstone gneiss. In the quarries its lower division only is exposed. The rock nearest to the gneiss is, as before mentioned, a conglomerate, the sandstone-like cement of which contains larger or smaller rounded fragments of quartz and grains of felspar, the latter sometimes being, as in the millstone gneiss, converted into kaolin powder. In the fourth volume of his "Anteckningar"[1] Hisinger has given a tolerably accurate description of this conglomerate, but he says afterwards, erroneously, that the millstone bed is in immediate contact with a fine-grained sandstone.[2] The conglomerate is usually concreted into one mass with the millstone gneiss, but the limit, as may be expected from the different nature of the rocks, and above all, from their unconformable stratification, is very distinct. As yet no fossils have been found in it.

The thin conglomerate is followed, often without any very distinct line of demarcation, by the main mass of the lower sandstone, which is fine-grained, hard, greyish, and reddens in the air. Except in its undermost parts, its layers are very thin. It is interbedded with thin layers of a greenish-grey shale. Sometimes the sandstone, owing to a greater number of laminæ of mica, assumes a schistose structure. Hisinger and Sir R. Murchison have already described this sandstone and the shale alternating with it ("bluish-grey clay" Hisinger, "greenish-grey shale" Murchison). Dr. Wallin has not only pointed out all its petrographic characters, but also remarked that it contains peculiar fossils, and for that reason, on the suggestion of Professor Torell, he has termed it "Eophyton sandstone," reserving the name of Fucoid sandstone for the upper and softer parts. It is especially in the deep and numerous quarries on the north-eastern side of the mountain that sections of the Eophyton sandstone are exposed, but the limit next the Fucoid sandstone proper is not exposed there and has not been observed in any other place. The thickness therefore has not been ascertained. Dr. Wallin has found it to be at least 30 feet.

It was in this sandstone that Dr. Wallin during the summer 1867 discovered the *Eophyton Linnæanum*, Torell, and in the following year he added the *Arenicolites spiralis*, Torell. Last autumn I visited Lugnås, and collected the fossils I am about to describe. The rock, being very fine-grained, has preserved distinct casts of the

[1] P. 49.

[2] Vol. v., p. 67; Vol. vi., p. 60.

plants and animals which lived in, or were swept into, the water where it was deposited, so that the most delicate parts can often be distinguished with accuracy. The knowledge, however, to be gained from the materials hitherto obtained is far from being satisfactory, and the interpretations must often be uncertain. Still I have thought it advisable not to delay publishing my observations, as every contribution that may throw some light on so remote a period, can hardly fail to be acceptable.

Arenicolites spiralis, Torell.—The worm described under this name by Professor Torell, at the last meeting of the Scandinavian Naturalists in Christiana, is one of the commonest fossils, especially in the shale. The spirally curled form, which has given rise to the name, is easily recognized and is very constant. Its relations to the numerous burrows which are found along with it are difficult to decide. The thickness of the burrows—almost the only character to be relied upon—is nearly the same as in the spiral form.

Lingula (?) *monilifera*, n., Plate XI., Figs. 1 and 2.—Of this species, with the exception of a nearly complete and very distinct cast of the outside of the one valve, Pl. XI. Figs. 1 and 2, I found only a few fragments. The inner parts are not visible in any specimen, and the generic determination therefore cannot be settled; but by the size and the general form, and, above all, by the sculpture of the shell the species is easily distinguished from all the Brachiopods with which I am acquainted. In the cast the apex itself is not visible, and one cannot therefore decide whether it is formed by the dorsal or ventral valve. The shell would seem to have been oval and very much depressed, except near the apex, where the sides are more sloping. The length and breadth are about 22 millimetres. The shell is ornamented with extremely close and fine longitudinal, slightly diverging, raised and beaded lines, of which about five may be counted within the breadth of a millimetre. The lines of growth are apparent only near the front margin. Judging from the thickness of the detached slabs in which this species was found, it would seem to have made its appearance in the undermost layer of the Eophyton sandstone, and may thus be considered the earliest Mollusk hitherto known.

In a slab of schistose sandstone I found a Brachiopod which, in the sculpture of the shell, bears some resemblance to the preceding species, but in other respects, as far as one can judge from the indistinct fragments, is widely different. On the surface of the slab lie two shells, of which the margins only are preserved, and even these but incompletely, the middle part being totally effaced. The contour seems to have been almost circular with a diameter of about 50 millimetres. The shell, like that of *Lingula monilifera*, bears raised, beaded lines, but these lines here seem to be directed towards the centre of the shell; near the circumference their distance from each other is somewhat less than a millimetre. From the general form of the shell this species may most likely be supposed to be a *Discina* or *Trematis*.

Eophyton Linnæanum, Torell,[1] Plate XI. Figs. 3 and 4, and Plate XII.—It is to be hoped that Professor Torell will soon communicate some further observations about this remarkable but as yet not sufficiently known species. In the meantime I may venture upon the following remarks. With the materials I have hitherto obtained it is hardly possible to give a full specific description, and I must therefore confine myself to describing separately some of the specimens collected. In Fig. 3 of Plate XI. is shown a piece of sandstone with two specimens lying parallel and close together. The one to the left agrees, as far as I can recollect, with the specimens exhibited by Professor Torell himself, which I had an opportunity of seeing at the last meeting of Scandinavian Naturalists in Christiania. It is a regularly convex fragment of a stem, of equal breadth throughout, and perfectly straight, 170 millimetres long and about 25 millimetres broad, with a height of about six millimetres.[1] Along its whole length it bears a large number of regular furrows, say 35, the breadth of which is nearly the same as that of the intervening raised ribs. Towards the sides both the furrows and ribs are generally somewhat larger, and especially a few millimetres from the margin one broad and deep furrow is to be seen, besides some ribs raised above the others and at nearly regular distances from one another. These higher ribs are for the most part arranged in pairs and separated by a comparatively broad furrow. Such a pair runs along the middle, and several others are more or less discernable on the right side, this arrangement being less conspicuous on the left side. The smaller ribs and furrows running between the larger are exceedingly fine, and it has not therefore been possible to represent them all distinctly enough in the figure, since even in the original they are to be distinguished only with difficulty. All the ribs and furrows are straight except in the uppermost part (*a*), where those in the middle are gently bent asunder, as though nearly the origin of a branch. On the sides of the stem (*b* and *c*) are to be seen awl-like appendages, the organic connexion of which with the stem is somewhat uncertain.

The specimen on the right hand is depressed and mutilated and not visible throughout its whole breadth, which must have been considerable, the preserved portion being more than 25 millimetres broad. The ribs and furrows are much coarser and much less regularly arranged. On the left side they are comparatively equal and small in size, though coarser than in the former specimen. Further to the right hand the breadth of the furrows is much larger, sometimes amounting even to three millimetres. The ribs are several times narrower than the furrows, the coarser among them being often divided. Even in this specimen they are for the most part straight, but near the left margin the outer ones (*d*) bend outwards, probably where a branch has been given off. Close above this flexion the sculpture is effaced; when the furrows in the upper part again appear, they run quite straight.

[1] Bidr. till Sparagmitetagens geogn. och pal., p. 36, t. ii. f. 3, t. iii. f. 1–3.

[1] In the figure the inner part of the right side appears more depressed than in the original.

Fig 4 in the same plate represents a specimen, somewhat weathered, the outlines of which are therefore not quite distinct. Its visible breadth is about 15 millimetres. In the upper part a branch or a leaf (?) runs out, the base of which forms a ridge obliquely crossing the whole breadth of the stem. Its free portion is bent almost straight upwards, parallel to the stem, but broken so near the base, that its form cannot be conjectured. The longitudinal furrows of the stem are close and narrow, but in consequence of the weathering, not very distinct. In the lower portion they are gently and irregularly bent, then straight, until immediately beneath the oblique ridge they are suddenly bent in the same direction as the ridge; above this they are quite straight. In the appendicular organ no furrows are visible, but that, perhaps, depends partly on the matrix being there more coarse-grained. This specimen agrees in many respects with the right-hand one in Fig. 3, and in order that the conformity between the two in the course of the furrows may be more conspicuous, it has been drawn inverted in Fig. 4*a* by the side of its presumed analogue in Fig. 3. At *d* in Fig. 4*a* as at *d* in Fig. 3 the ribs to the left bend outwards, and close above this point there are no furrows in either specimen, and when these reappear in the upper part they are straight, the right-hand furrows not partaking of the flexion, but running without interruption.—Though probably not belonging to this fossil, a small conical tubercle (*a* in Fig. 4), seems worthy of attention, arising, as it does, in the very margin of the stem, and being surrounded by an annular eminence.

Plate XII. represents a slab which evidently has been long exposed to the air, so that in some places the sculpture is not so conspicuous as in that just described. It contains several larger and smaller fragments of stems. They are all distinguished from the foregoing by their inferior breadth, which is from four to six millimetres. The furrows are in all somewhat conformable and narrow, though for the most part larger than those in the first-mentioned specimen. Some of the stems are depressed, but in some of them the height above the surface of the slab is nearly as great as the breadth; the more convex ones are often angular. The largest specimen has a length of about 100 millimetres. It is divided into two branches of equal size, making an angle of about 40°, and having the same breadth as the common stem. The left branch seems to be somewhat tapering, but that depends no doubt on its gradually sinking in the matrix. Between the branches lies a fragment (*a*) the extremities of which seem to be abruptly cut off at their contact with them. In the axilla of the branches an oblong, irregular, convex mass (*b*) runs out, which, however, shows no trace of structure. The common stem is slightly bent, and has its hinder part sunk in the matrix; but in its continuation there lies a very convex fragment (*c*) of similar form. From beneath the anterior part of this another depressed fragment (*d*) projects with more obscure outlines. Whether they are coherent or not cannot be seen, a formless mass covering the point at which they meet.—Among the other specimens the following ought to be especially noticed. At *e* a short but large fragment is observed. Its posterior section shows some small cavities disposed obliquely one above the other at nearly regular distances, which may, perhaps, be interpreted as traces of the inner structure. To the right lies a longer and narrower fragment (*f*) which has possibly cohered with another (*g*), of which only a small portion is preserved, in the very margin. Both are there bent, as if they had been united outside the present margin of the slab.—By the side of these lies a specimen (*h*) with deep furrows and sharp ribs. In this, as in some others, the furrows sometimes show a slight trace of a transverse articulation, as if each furrow had consisted of a row of small excavations, but this may have arisen from the weathering of the slab.—At *i* a fragment is seen, which is remarkable for its great convexity and distinctly angular shape.—An irregular raised body (*k*), marked by two parallel rows of tubercles, is probably of organic origin, and is suggestive perhaps of the presence of terrestrial animal life.

Several other slabs not figured contain specimens of *Eophyton Linnæanum*; they give, however, but little information. One of them has almost the whole surface covered with fragments of stems, some of which are branched, but the weathering has made them too obscure to be described.

It seems premature to speculate on the affinities of this fossil, which bears so little resemblance to forms previously known, and ampler materials are no doubt required in order to come to any certain results in this respect. Its organic origin cannot reasonably be questioned, and hardly any doubt can exist as to its belonging to the vegetable kingdom. If it were not of vegetable origin, it could not be interpreted otherwise than as the track of an animal. Such a supposition is contradicted especially by its being branched; a track cannot be supposed to have taken such a form as that shown for instance in Pl. XI. Fig. 4. And even apart from the branching, this interpretation can hardly be maintained if the characteristic furrows be considered, at least I have never seen a description of any tracks with which this fossil could be compared. If the vegetable nature of *Eophyton* be granted, the difficulty of deciding to which group it is to be referred still remains. This difficulty is augmented by the scarcity of fossil plants in the oldest deposits, that might enable us to draw a comparison. From the whole Cambrian and the greater part of the Silurian system no remains of other plants than Algæ have hitherto been obtained. That the *Eophyton* cannot be referred to that class is however evident. Several eminent algalogists have examined the fossil and they have all unanimously and with the greatest certainty declared that it cannot have any affinity with the Algæ. It is then among the vascular Cryptogams and Monocotyledons, that the relations of *Eophyton* are to be looked for. Professor Torell refers it to the latter, and though its phanerogamous nature be not yet fully ascertained, its general habit in many respects reminds us of them. He suggests, however, a near relation to *Cordaites*, a genus referred by several authors to the *Lycopodiaceæ.* This opinion is founded on the resemblance between the leaves of *Cordaites* and *Eophyton.* It is, however, doubtful, whether the organs interpreted as leaves in *Eophyton* are really such. Judging from the figures given by Professor Torell, they seem to be the same parts which I have described as portions of stems, and which, from their branching not resembling that of compound leaves, their frequent convex shape, etc., I could not regard as leaves. In the restoration given by Dawson,[1] the stem of *Cordaites* has very short joints, and if that be true, there is still less reason to assume a nearer relation between *Cordaites* and *Eophyton,* the stem of the latter, at least in the specimens hitherto found, showing no articulation. Thus, though a great uncertainty still remains as to the place of *Eophyton* in the natural system, it can hardly be doubted that it is of a far higher organization than any plant hitherto known from the oldest deposits.

With regard to the mode of fossilization of the *Eophyton,* it seems probable that the plants immersed in the water made impressions on the mud upon its bottom, and that, after the plants themselves had been dissolved, their impressions were filled with sand. In this manner the fact is to be explained that one specimen often is, as it were, cut off when in contact with another. We must accordingly suppose that the mutilated specimen has made an impression, and that afterwards the other has been laid across and partially obliterated it.

Eophyton Torelli, n. sp., Plate XIII.—Although it is very uncertain whether this species has any nearer relation to the preceding typical species of the genus *Eophyton,* I have thought fit to describe it under the same generic name. Extensive researches into the plant-remains of the Eophyton sandstone are still necessary, before any certain generic characters can be given, and there is therefore reason in keeping them all provisionally under the name *Eophyton.*

Eophyton Torelli is much scarcer than *E. Linnæanum;* at least, I have found it only on one slab of sandstone, some parts of which are represented in Plate XIII.

In Fig. A is shown a stem-fragment about 90 millimetres in length. The foremost half, the breadth of which is 10—12 millimetres, is very convex and distinctly angular, so that four sides are visible. Both the outer sides are almost vertical—in the figure the left side cannot be seen, but it is of about the same breadth as the right. The upper sides are gently sloping and somewhat concave, the left being broader than the right. The hinder part becomes gradually more and more depressed, and consequently the breadth increases, until it attains 19 millimetres. The surface is generally smooth, except that on the hinder part some very faint traces of longitudinal furrows are seen. The most characteristic parts of this specimen are four scales, which seem to be spirally arranged round the axis, but, as far as visible, at unequal distances. The first (*a*), which is placed on the left margin of the depressed portion, is broadly lanceolate and has a length of about 8 millimetres and a maximum breadth of 4 millimetres. At a distance of 15 millimetres, on the middle ridge between the upper sides, another scale (*b*) of about the same shape and size is placed. About 30 millimetres in advance a similar organ (*c*) projects from the upper left hand side, and a fourth (*d*) is seen, as it were, hanging down from the angle of the outer right side. The scale at *c* seems to have been cleft in such a manner that some organ, which had for the most part been destroyed, has been rendered visible.

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[1] Acadian Geology, second ed. p. 458.

Of the nature of the objects represented by the other figures, and of their relation to the specimen just described, it is at present difficult to form an idea. In order to draw attention to them, however, I have thought fit to give figures of them. Their presence in the same slab makes it to a certain extent probable that some of them at least belong to the stem described above.

In Fig. B is shown an oblong body strongly convex, with a very wrinkled and rough surface. It might perhaps be conjectured to have been a spicate inflorescence. Its length is 45 millimetres, the breadth about 10 millimetres. From the right side (*a*) two narrow, oblong linear bodies run out, one across the base of the other. Their outlines are very distinct on the outer side, on the inner not quite so much so. Both have along the middle a faint furrow, in the continuation of which is seen a faint threadlike ridge (*b*). A third body of the same form, but shorter and broader, lies at their base. In B′ they are represented somewhat magnified.

In the anterior part of Fig. C a cylindrical body (*a*) is seen, perhaps analogous to *a* in Fig. A. In the posterior part at *b* there are three conical tubercles, arranged in a row, round which the surface of the stone is finely striated.

The objects shown by the portion D of the same slab are for the most part very obscure. On the left side are seen several môre or less elevated parts (*a*) marked by faint longitudinal furrows; they are probably portions of a depressed stem. On the right side is seen a broken, cylindrical, wrinkled body, somewhat resembling the one represented in Fig. B, together with some straight linear ribs, while behind them there is a narrow tube, at the side of which lies an oblong body (*b*) that may be compared with *a* in C. Of none of these objects will I venture any interpretation.

Rhysophycus dispar, n.sp.—There occurs in the Eophyton sandstone more frequently than any other, a strange fossil bearing a close resemblance to certain forms described by Hall,[1] Billings,[2] and Dawson,[3] under the generic names of *Rusophycus*[4] and *Rusichnites*. It always consists of a system of linear eminences or ribs, arranged symmetrically and more or less transversely on each side of the middle line. The form most closely agreeing with the descriptions given, especially of *R. bilobatus* (Hall) from the Clinton group, and *R. Grenvillensis* (Billings) from the Chazy limestone of North America, may be considered as the type. It is an oblong body, very convex and broader at one of its ends, which may be called the anterior; it is divided into two symmetrical lobes by a longitudinal furrow, which in the hinder portion is narrow and shallow, but increases forwards in size, so that the front ends of the lobes are completely separated from each other. The width of the whole fossil does not always increase regularly and continuously; the enlargement usually takes place more slowly before the middle and sometimes entirely ceases. Even when the width of the whole increases continuously, the lobes taper before the middle, in consequence of the increasing breadth of the longitudinal furrow. Each lobe has a multitude of close, rather regular narrow ribs, which in the hinder portion meet in the median furrow, forming an angle, the top of which is directed backward. In the middle, where their direction is often suddenly altered, they are almost at right angles with the median line. In the anterior portion, where the ribs of the two lobes do not touch, their projections, if drawn out, would form an angle with the top directed forwards. In consequence of this change in their direction, the ribs are crowded together on the sides and diverge inwards. The dimensions, absolute as well as relative, vary, but not to any great extent. The length I have found to vary between 50 and and 80 millimetres. The greatest breadth is sometimes but little less than the length, but it does not usually exceed two-thirds. The height is greatest in the middle, being sometimes equal to a third of the length. There is no trace of an axis. Hall considers that he has found such an organ in the *R. bilobatus*, but, as stated by Dawson, the supposed stem is undoubtedly nothing but a tube of a worm. Even in the Vestrogothian species such tubes are sometimes seen to issue here and there between the ribs, but never in such a situation as to be mistaken for branches or stems.

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[1] Palæontology of New York, vol. ii., p. 23. 24.

[2] Palæozoic Fossils of Canada, vol i., p. 101.

[3] On the Fossils of the genus Rusophycus, Canadian Naturalist, Oct. 1864, 363.

[4] According to the derivation the name is to be written *Rysophycus*, or, with Eichwald (Lethæa Rossica, vol. 1, p. 54) *Rysophycus*.

The ribs are but comparatively seldom united into such convex bodies as are here described. They are usually extended almost horizontally; sometimes whole slabs are covered with such systems. The ribs are in this case straight or but slightly bent, more nearly parallel with each other and usually almost at right angles with the median lines. The opposite ribs are seldom in contact, and the two halves are therefore entirely separated. Even the approximate ribs of the same lobe are seldom contiguous. Sometimes transitions between this form and the one above described are seen. Thus, in one specimen, the ribs are more crowded and meet at the median line; each lobe is slightly convex, but of the same height throughout its whole length, while the typical form is highest in the middle and sloping both forwards and backwards. The specimens of the horizontally expanded form hitherto collected have a length of from 15 to 80 millimetres; the number of the ribs varies according to the length, but depends also in some degree upon their being more or less crowded. The breadth is between 15 and 30 millimetres, but is in general nearly the same in different parts of the same specimen.

Annelid burrows often have some raised or depressed ribs; sometimes they are seen to wind between the ribs, now over, now under them.

Although the specimens hitherto obtained do not exhibit a complete series of transitions, it is highly probable that the convex and the more horizontally expanded form belong to one and the same species, more especially as Dawson has found two analogous forms of *R. Grenvillensis.*

According to Hall and Dawson the allied American forms always occur on the under side of the strata, where these are reposing on shale, and are thus casts of impressions once formed upon the soft clay. Without doubt the same is also the case with the fossil occurring in Vestrogothia, but I have had no opportunity of directly verifying it.

The genus *Rhysophycus* is still one of the least understood; it has not even been ascertained, whether it be of vegetable or animal origin. Besides, as now defined, it includes objects too heterogeneous. Thus *R. clavatus* and *subangulatus* Hall and *R. embolus* Eichw. seem to have a closer relation to *Arthrophycus Harlani* (Conrad) Hall, than to the other forms referred to *Rhysophycus*. *R. dispar* differs from *R. bilobatus* and *Grenvillensis*, chiefly in the greater regularity of the ribs and of the change of their direction, and in the considerably increased breadth of the longitudinal furrow. In other respects those three species have so much in common, that they must be considered as closely related, and interpreted in the same way. I can find no reason with Hall to refer them to the Algæ. If they were of that origin, we might expect to find a stem or axis. Dawson, who has especially examined the *R. Grenvillensis*, believes the more horizontally expanded form to be the cast of the tracks of some Trilobite, and the convex to be the cast of a hole excavated by the Trilobite for shelter or repose. He therefore alters the generic name into *Rusichnites*. This interpretation does not seem an unreasonable account of the horizontal form, but it does not explain so well the convex form; especially since it is difficult to understand how the ribs could have got the direction they have in *R. dispar*. The further objection that no Trilobites or other Crustacea are found in the lower Cambrian sandstone of Vestrogothia, is of less importance, as from the discoveries already made it is probable that even Trilobites lived when this layer was formed. Salter[1] thinks the species referred to the genus *Rhysophycus* to be short forms of the genus *Cruziana* of d'Orbigny,[2] and there certainly seems to be a great affinity between the two. D'Orbigny simply refers his *Cruziana* to the Articulata; Salter considers it an Annelid tube, somewhat coriaceous. D'Orbigny's name has priority.

On account of its plant-remains the Eophyton sandstone is considered by Professor Torell as probably a freshwater deposit. That this cannot be the case is proved by its also containing Brachiopods. From the frequent occurrence of *ripplemarks* and *rain-prints* it may be supposed to be a shore-deposit.

[1] Bigsby's Thesaurus Siluricus, p. 2.

[2] Voyage dans l'Amérique méridionale, iii., 2, p. 30, pl. 1, f. 1, 2; 1842.—Marie Rouault altered the name to *Fræna*, Bull. Soc. Géol. France, 2 Sér. Vol. vii. p. 729.

The upper division of the sandstone layer, or the Fucoid sandstone proper, is not so poor in fossils as has hitherto been supposed. In an earlier memoir[1] I have mentioned the discovery of a *Lingula* at Djupadalen near Karleby. During the last summer I searched in vain for the same species, but in place of it I collected several specimens of another *Lingula*. Among the specimens obtained not one is quite complete, and they exhibit no decisive generic characters. The rather singular sculpture of the shell however is admirably well preserved, and on that account the species may be named *Lingula* (?) *favosa*. The shell is depressed and has almost the form of a sector of a circle, somewhat exceeding a quadrant; its length is about 5 millimetres, the breadth being about 6 millimetres. The anterior half of the shell bears some sharp lines of growth and a few punctæ, but otherwise it is smooth. Behind the middle there follows a space closely beset with small excavations. At the very apex, which in all the specimens is more or less damaged, the shell seems again to be smooth. The colour, at least outside, is of a whitish blue.

EXPLANATION OF THE PLATES.

Plate XI. Figs. 1 and 2, *Lingula monilifera*, n.
" Figs. 3 and 4, *Eophyton Linnæanum*, Torell.
Plate XII. *Eophyton Linnæanum*, Torell.
Plate XIII. *Eophyton Torelli*, Linnarsson.

V.—On the Formation of Ravines by Recent Drift Accumulations.

By G. Henry Kinahan, M.R.I.A., etc.

It is not unusual in drift deposits, banked on hill slopes, to find a deep cut occupied by a very minute stream. These cuts or ravines are supposed to be due to the streams; having been excavated by them in the banks of drift. If a ravine of this class is formed in one of the older drifts—namely, the Boulder-clay-drift or the Moraine-drift—it must apparently have been cut by a stream, but much of the drift banked on hill slopes is quite recent; that is formed by meteoric abrasion, and being added to at the present day. In these recent drifts, ravines are of common occurrence, and I would suggest that, instead of the stream cutting its ravine, meteoric abrasion has heaped up the banks, and the only action capable of being done by such a stream, is to keep its channel clear. Such accumulations of drift are very frequent in association with *Maums*, or connecting gaps across mountain-ranges, and there are always ravines in the banks,—yet by no arrangement of the water-supply, could streams be formed that would have the power to excavate them. In the accompanying sketch of Maumgeeha, Yar-Connaught, there is a maum, below which is a recent drift-bank with a ravine and its accompanying stream. None of the surface drainage of the hills on either side of the maum can get into the stream, it being fed by a spring, while the surface drainage of the mountains flows as represented by the arrows, and yearly the shed from the hills adds to the height of the banks. From this would it not appear that previous to the formation of the drift there was a stream in the valley fed, as it is now, by a spring; that the shedding from the hills came down yearly into the valley, but could not fill it up as the stream always keeps its channel clear, therefore the debris was gradually banked up, leaving a ravine in the place that from the first was occupied by the stream? What seems to be in favour of this suggestion is the fact, that if one hill is higher than the other, or one hill sheds more than the other, the bank of the ravine, on the side next the hill that sheds most, will be highest; or, if one hill suffers but little waste, the drift will only occur, in mass, on one side of the stream, steep on the stream side and tailing from it for a considerable distance down the valley. Furthermore, if there is a cross-section exposed in one of these drift-banks, as may often be seen in road-cuttings and mining operations, it will be found stratified and dipping away from the ravine, as represented in the Woodcut (Fig. 2).

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[1] Bidrag till Vestergötlands Geologi. Ofvers. af K. Vet. Akad. Forh. 1868.

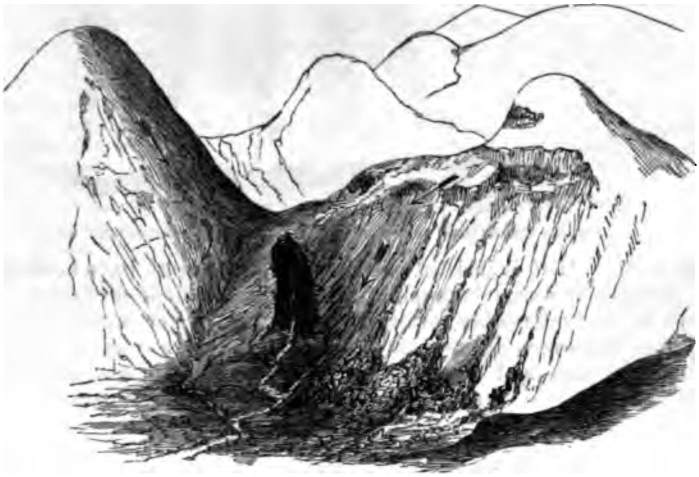

FIG. 1.—Sketch showing *Maum* with an accompanying bank of recent Drift, a ravine being seen in the latter.

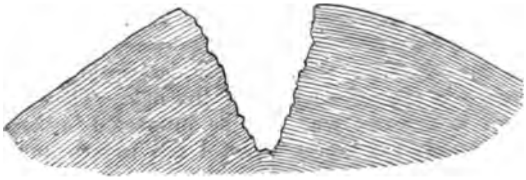

FIG. 2.—Section of recent Drift-bank.

Recent Drift-banks also often occur below an escarpment near the summit of a mountain range; and although they are arranged in ridges and hollows, yet there never could have been a head of water to excavate the latter. The accompanying sketch of one of the hills in the Barony of Burren, Co. Clare, shows this class of drift-bank. If it is insisted on that the valleys must have been cut by streams, it seems impossible to account for their formation, as there is no water-table on which a head of water could collect. To me, however, it appears evident that there was a certain amount of rain and river action, and a certain amount of meteoric abrasion; but the carrying power (*i.e.* the first named) not being equal to the abrading force, the drift was not conveyed away—the little water there was must find a way somewhere, therefore, in the first instance, it flowed over the lowest places in the escarpment, and afterwards, by the accumulation of the drift, it was concentrated in those places and thereby was enabled to keep the hollows clear of drift and mould the ridge to their present form.

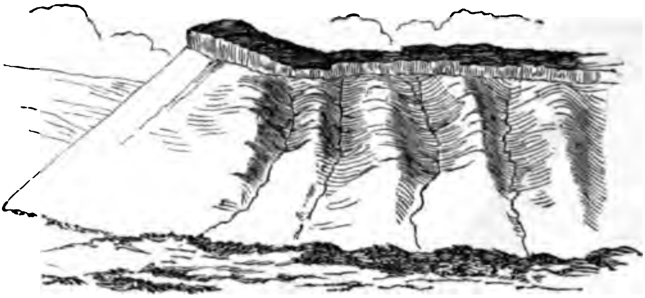

Fig. 3.—Recent Drift banked on a hill-slope below an escarpment.

Glaciers act somewhat similarly to streams, for the debris brought down by the meteoric abrasion and shedding into a valley, the centre of which is occupied by a glacier, is banked up in ridges outside the margin of the ice-stream.[1] And Marine action has, to some extent, a like power; for much of the debris, carried down by rivers, is thrown up in banks, instead of being spread out evenly over the bed of the ocean.

VI.—Alphabetical Catalogue of Type Specimens of Fossil Fishes in the Collection of Sir Philip de Malpas Grey Egerton, Bart., M.P., at Oulton Park.

The object of the accompanying list of Fossil Fishes is merely to record, for future palæontologists, the depository of a few specimens which have furnished the materials for descriptions and figures of species recorded in the publications of the day. They are available for inspection to any one who may be interested in their examination, and I am only too happy when I can induce any geological or palæontological students to come and see them.—P. M. G. E.

Acanthoderma, Ag.
— *spinosum*, Ag. P. F., tom. 2, pt. 2, tab. 75, fig. 4. *(Counterpart.)*

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[1] See Dr. Hayes's description of the Greenland Glacier "Open Polar-sea;" Dr. *Hooker* on the Glacier in the Valleys of the Himalaya; etc.

ACANTHOPLEURUS, Ag.
— *serratus*, Ag., P. F., tom. 2, pt. 2, tab. 75, fig. 2.
ACIPENSER, Linn.
— *Toliapicus*, Ag., P. F., tom. 2, pt. 2, feuil. 280.
ACROLEPIS, Ag.
— *Sedgwicki*, Ag., King Perm. Foss., pl. 25, P. F., tom. 2, pt. 2, feuil. 80.
ANENCHELUM, Ag.
— *glarisianum*, Ag., P. F., tom. 5, tab. 37, fig. 1.
— ,, ,, P. F., tom. 5, tab. 37, fig. 2. *(Counterpart.)*
— *heteropleurum*, Ag., P. F., tom. 5, tab. 37*a*, fig. 3. *(Counterpart.)*
— *isopleurum*, Ag., P. F., tom. 5, tab. 37, fig. 3.
ASPIDORHYNCHUS, Ag.
— *Anglicus*, Ag., P. F., tom. 2, pt. 2, feuil. 139.
ASTERACANTHUS, Ag.
— *granulosus*, Eg., M. G. S., Dec. 8, pl. 1, fig. 1.
— *ornatissimus*, Ag., P. F., tom. 3, tab. 8, fig. 7.
— ,, ,, P. F., tom. 3, tab. 8, fig. 8.
— *papillosus*, Eg., M. G. S., Dec. 8, No. 3, p. 3.
— *semisulcatus*, Ag., P. F., tom. 3, tab. 8*a*, fig. 8.
BELONOSTOMUS, Ag.
— *Anningiæ*, Ag., P. F., tom. 2, pt. 2, feuil. 143.
— *Münsteri*, Ag., P. F., tom. 2, pt. 2, tab. 47*a*, fig. 2.
BERYX, Cuv.
— *germanus*, Ag., P. F., tom. 4, tab. 14*e*. *(Counterpart.)*
CALAMOPLEURUS, Ag.
— *Anglicus*, Dixon *(hians Eg.)*, Dixon, F. S., pl. 32, fig. 12.
CATURUS, Ag.
— *macrodus*, Ag., P. F., tom. 2, pt. 2, feuil. 118.
CENTROLEPIS, Eg.
— *asper*, Eg., M. G. S., Dec. 9, pl. 5. *(Counterpart.)* P. F., tom. 2, feuil. 304.
CEPHALASPIS. Ag.
— *Lyelli*, Ag., P. F., tom. 2, tab. 1*a*, fig. 1.
CERATODUS, Ag.
— *disauris*, Ag., P. F., tom. 3, tab. 19, fig. 19.
CHEIRACANTHUS, Ag.
— *microlepidotus*, Ag. P. F. V. G. R., tab. 15, fig. 2.
CHIMÆRA, Linn.
— *Agassizi*, Buck. (Ischyodus Eg.), P. F. tom. 3, tab. 40*c*, figs. 14–15.
— *Bucklandi*, Eg. (Ganodus Eg.), P. G. S., vol. 4, pt. 1, p. 153. P. F., tom. 3, tab. 40*c*, fig. 19.
— *Colei*, Buck.) Ganodus Eg.), P. F., tom. 3, tab. 40, figs. 9–10.
— *curvidens*, Eg. (Ganodus Eg.), P. G. S., vol. 4, pt. 1, p. 154.
— *dentatus*, Eg. (Ganodus Eg.), P. G. S., 1847, p. 353.
— *Egertoni*, Buck. (Ischyodus Eg.), P. F., tom 3, tab. 40, figs. 1 to 10.
— *emarginatus*, Eg. (Ganodus Eg.), P. G. S., vol. 4, pt. 1, page 154.
— *falcatus*, Eg. (Ganodus Eg.), P. G. S., vol. 4, pt. 1, p. 154. P. F., tom. 3, tab. 40, fig. 13.
— *Greenovi*, Ag. (Elasmodus Eg,), P. F., tom. 3, tab. 40, figs. 11 to 16.
— *helvetica*, Eg. (Edaphodon Buck.), P. G. S., vol. 4, pt. 1, page 154.
— *Johnsoni*, Ag. (Ischyodus Eg.), P. F., tom. 3, tab. 40*c*, fig. 22.
— *neglecta*, Eg. (Ganodus Eg.), P. G. S., vol 4, pt. 1, p. 153. P. F., tom. 3, tab. 40*c*, fig. 11.
— *Oweni*, Buck. (Ganodus, Eg.), P. F., tom. 3, tab. 40, fig. 6.
— ,, ,, ,, P. F., tom. 3, tab. 40, fig. 7.
— *psittacina*, Eg. (Ganodus Eg.), P. G. S., vol. 4, pt. 1, p. 153. P. F., tom. 3, tab. 40*c*, fig. 12.
— *rugulosa*, Eg. (Ganodus Eg,), P. G. S., vol. 4, pt. 1, p. 154.
— *Townshendi*, Buck. (Ischyodus Eg.), P. F., tom. 3, tab. 40, fig. 20.
CHONDROSTEUS, Ag.
— *acipenseroides*, Ag., Phil. Trans., 1858, pl. 68, fig. 1. P. F., tom. 2, pt. 2, feuil. 280.

CLUPEA, Linn.
— *brevis*, Ag. P. F., tom. 4, tab. 62, fig. 1.
— ,, ,, P. F., tom. 5, tab. 62, fig. 2,
COCCOSTEUS, Ag.
— Model of Cranial Plates, by Hugh Miller, J. G. S., vol. 16, p. 129, f. 1.
— Paper Model of Ventral Plates, by Hugh Miller, J. G. S., vol. 16, p. 130, f. 2.
— Model of Abdominal Plates, by Hugh Miller, J. G. S., vol. 16, p. 132, f. 5.
— Model of Lateral Plate, by Hugh Miller, J. G. S., vol. 16, p. 134, f. 8.
— Model of Cephalic Plate, by Hugh Miller, J. G. S., vol. 16, p. 134, f. 9.
— Paper Model of Tail, by Hugh Miller, J. G. S., vol. 16. p. 134, f. 7.
— *decipiens*, Ag., P. F. V. G. R., tab. 9, fig. 2. *(Counterpart.)*
— ,, ,, P. F. V. G. R., tab. 9, fig. 3.
— ,, ,, P. F. V. G. R., tab. 9, fig. 1.
— ,, ,, P. F. V. G. R., tab. 9, fig. 1. *(Counterpart.)*
— ,, ,, P. F. V. G. R., tab. 30*a*, fig. 19.
— *Milleri*, Ag., Model of Profile, by Hugh Miller, J. G. S., vol. 16, p. 133, f. 6.
— *pusillus*, McCoy, Model of Head, by Hugh Miller, J. G. S., vol. 16, p. 131, f. 3.
— ,, ,, Model of Dorsal Plate, by Hugh Miller, J. G. S., vol. 16, p. 131, f. 4.
CŒLACANTHUS, Ag.
— *caudalis*, Eg., King Perm. Foss., tab. 28, M. G. S., Dec. 12, pl. 5, fig. 5.
— *elegans*, Newberry, M. G. S., Dec. 12, pl. 5, fig. 1.
— ,, ,, M. G. S., Dec. 12, pl. 5, fig. 2.
— ,, ,, M. G. S., Dec. 12, pl. 5, fig. 3.
— ,, ,, M. G. S., Dec. 12, pl. 5, fig. 4.
— *granulatus*, Ag., King Perm. Foss. Tab. 28 *bis*.
— *Münsteri*, Ag., P. F., tom. 2, feuil. 173. *(Counterpart.)*
CŒLOCEPHALUS, Ag.
— *salmoneus*, Ag., Rep. Brit. Ass., 1844, p. 307.
CŒLOPOMA, Ag.
— *Colei*, Ag., Rep. Brit. Ass., 1844, p. 307.
— *læve*, Ag., Rep. Brit. Ass., 1844, p. 307.
CONODUS, Ag.
— *ferox*, Ag., P. F., tom. 2, pt. 2, feuil. 105.
CORAX, Ag.
— *Egertoni*, Ag., P. F., tom. 3, tab. 36, fig. 7.
— *pristodontus*, Ag., P. G. S., 1844, p. 383.
COSMOLEPIS, Ag.
— *Egertoni*, Ag., M. G. S., Dec. 12, pl. 1, fig. 2.
CTENACANTHUS, Ag.
— *tenuistriatus*, Ag., P. F., tom. 3, tab. 3, fig. 7.
CTENODUS, Ag.
— *Murchisoni*, Ag., P. F., tom. 1, feuil. 35.
CTENOPTYCHIUS, Ag.
— *apicalis*, Ag., P. F., tom. 3, tab. 19, figs. 1–1*a*.
CYCLOBATIS, Eg.
— *oligodactylus*, Eg., J, G. S., 1845, p. 225.
CYCLURUS, Ag.
— *Valenciennesii*, Ag., P. F., tom. 5, tab. 53, fig. 3.
DAPEDIUS, Dela Beche.
— *micans*, Ag. P. F., tom. 2, feuil. 304.
DIPLACANTHUS, Ag.
— *striatulus*, Ag., P. F. V. G. R., tab. 13, fig. 4.
DIPLODUS, Ag.
— *gibbosus*, Ag., P. F., tom. 3, tab. 22*b*, fig. 1.
DIPLOPTERUS, Ag.
— *macrocephalus*, Ag., P. F. V, G. R., tab. 16, fig. 1. *(Counterpart.)*
DIPTERUS, Sedg. and Murch.
— *macrolepidotus*, Ag. Siluria, ed. 2, p. 287, fig. 73. M. G. S., Dec. 10, p. 14, fig. 10.

EGERTONIA, Cocchi.
— *isodonta*, Cocchi, Pesch. Lab., tom. 1, fig. 2.
ENCHODUS, Ag.
— *serratus*, P. G. S., 1844, p. 383.
ENDACTIS, Ag.
— *Agassizi*, Eg. M. G. S., Dec. 9, pl. 4.
EUGNATHUS, Ag.
— *fasciculatus*, Ag. P. F., tom. 2, pt. 2, feuil. 105.
— *giganteus*, Ag., P. F., tom. 2, pt. 2, feuil. 104.
— *microlepidotus*, Ag., P. F., tom. 2, pt. 2, feuil. 12 and 104.
— *orthostomus*, Ag., P. F., tom. 2, tab. 57*a*.
— *scabriusculus*, Ag., P. F., tom. 2, pt. 2, feuil. 105.
— *tenuidens*, Ag., P. F., tom. 2, pt. 2, feuil. 105.
GLYPTOLEPIS, Ag.
— *leptopterus*, Ag. P. F. V. G. R., tab. 20, fig. 2.
— „ „ P. F. V. G. R., tab. 20, fig. 4.
— „ „ P. F. V. G. R., tab. 20, fig. 5.
— „ „ P. F. V. G. R., tab. 21, fig. 1.
— „ „ P. F. V. G. R., tab. 21, fig. 2.
— *microlepidotus*, Ag., P. V. G. R., tab. 21*a*, fig. 3.
GONIOGNATHUS, Ag.
— *coryphænoides*, Ag., Rep. Brit. Ass., 1844, p. 308.
GYRODUS, Ag.
— *perlatus*, Ag., P. F., tom. 2, pt. 2, feuil. 236.
— *trigonus*, Ag., P. F., tom. 2, pt. 2, feuil. 232.
HELODUS, Ag.
— *simplex*, Ag., P. F., tom. 3, tab. 19, fig. 9.
— „ „ P. F., tom. 3, tab. 19, fig. 8.
HETEROLEPIDOTUS, Eg. (Eulepidotus Eg.)
— *sauroides*, Eg., J. G. S., 1868, p. 503.
HISTIONOTUS, Eg.
— *angularis*, Eg., M. G. S., Dec. 8. pl. 5.
HYBODUS, Ag.
— *acutus*, Ag., P. F., tom. 3, tab. 10, figs. 4, 5, 6.
— *curtus*, Ag., P. F., tom. 3, tab. 8*b*, fig. 4.
— *marginalis*, Ag., P. F., tom. 3, tab. 10, figs. 20-21.
HYPSODON, Ag.
— *Lewesiensis*, Ag., P. F., tom. 5, tab. 25*b*, fig. 3.
ISURUS, Ag.
— *macrurus*, Ag., P. F., tom. 5, tab. 21, fig. 4.
LAMNA, Cuv.
— *complanata*, Eg., P. G. S., 1844, p. 387.
— *sigmoides*, Eg., P. G. S., 1844, p. 387.
LEPIDOTUS, Ag.
— *Mantelli*, Ag., P. F., tom. 2, tab. 30*c*, fig. 4.
— *notopterus*, Ag., P. F., tom. 2, tab. 35.
— *unguiculatus*, Ag., P. F., tom. 2, tab. 29*c*, fig. 1.
LEPRACANTHUS, Eg.
— *Colei*, Eg. P. F., tom. 3, feuil. 177 (*Counterpart*).
LEPTOLEPIS, Ag.
— *filipennis*, Ag. P. F., tom. 2, pt. 2, feuil. 134.
— *macropthalmus*, Eg. J. G. S. 1845, p. 231. M. G. S., Dec. 6, pl. 8, fig. 1.
— „ „ J. G. S. 1845, p. 231. M. G. S., Dec. 6, pl. 8, fig. 2.
— „ „ J. G. S. 1845, p. 231. M. G. S., Dec. 6, pl. 8, fig. 3.
LEUCISCUS, Klein.
— *latiusculus*, Ag. F. F., tom. 5, tab. 51*a*, fig. 5.
— *macrurus*, Ag. P. F., tom. 5, tab. 51*b*, fig. 3.
MACROPOMA, Ag.
— *Egertoni*, Ag. (EURYPOMA, Hux.), P. F., tom. 2, feuil. 174. M. G. S., Dec. 9, pl. 10.
MEGALOPS, Lacep.
— *priscus*, Ag. Rep. Brit. Ass. 1844, p. 308.

MEGALURUS, Ag.
— *Austeni*, Eg. M. G. S. Dec. 9, pl. 9.
— *Damoni*, Eg. M. G. S., Dec. 9, pl. 8, fig. 1.
MYLIOBATES, Dum.
— *marginalis*, Ag. P. F., tom. 3, feuil. 331.
— *nitidus*, Ag., P. F., tom. 3, feuil. 525.
— *Stokesi*, Ag., P. F., tom. 3, tab. 47, figs. 1-2.
NEMOPTERYX, Ag.
— *crassus*, Ag., P. F., tom. 5, tab. 22.
— *elongatus*, Ag., P. F., tom. 5, tab. 21*a*, fig. 1.
— ,, ,, P. F., tom. 5, tab. 21*a*, fig. 2.
NOTHOSOMUS, Ag.
— *octostychius*, Ag., P. F., tom. 2, feuil. 292. M. G. S., Dec. 9, pl. 6.
ODONTASPIS, Ag.
— *constrictus*, Eg., P. G. S., 1844, p. 388.
OPHIOPSIS, Ag.
— *breviceps*, Eg., M. G. S., Dec. 6, pl. 6, fig. 1. (*Counterpart.*)
— *dorsalis*, Ag., P. F., tom. 2, pl. 36, fig. 5.
OTODUS, Ag.
— *divergens*, Eg., P. G. S., 1844, p. 383.
OXYGNATHUS, Eg.
— *ornatus*, Eg., M. G. S., Dec. 8, pl. 9.*
OXYRHINA, Ag.
— *triangularis*, Eg., P. G. S., 1844, p. 386.
PACHYCORMUS, Ag.
— *curtus*, Ag., P. F., tom. 2, tab. 59.
— *latipennis*, Ag., P. F., tom. 2, pt. 2, feuil. 114. M. G. S., Dec. 9, pl. 3.
PALÆONISCUS, Ag.
— *arcuatus*, Eg., J. G. S., vol. 6, p. 7.
— *decorus*. Eg., J. G. S., vol. 6, p. 7.
— *Egertoni*, Ag., P. F., tom. 2, feuil. 302. M. G. S., Dec. 6, pl. 2.
— *Monensis*, Eg., J. G. S., vol. 6, p. 5.
PALÆORHYNCHUM, De Blain.
— *Egertoni*, Ag., P. F., tom. 5, tab. 34*a*, fig. 2.
— *latum*, Ag., P. F,, tom. 5, tab. 32, fig. 2. (*Counterpart.*).
— *longirostre*, Ag., P. F., tom. 5, tab. 34*a*, fig. 3.
— *microspondylum*, Ag., P. F., tom. 5, tab. 34*a*, fig. 1. (*Counterpart*).
PHOLIDOPHORUS, Ag.
— *crenulatus*, Eg., M. G. S., Dec. 6, pl. 5, fig. 1.
— ,, ,, M. G. S., Dec. 6, pl. 5, fig. 2.
— *fusiformis*, Ag., P. F., tom. 2, feuil. 288.
— *Hartmanni*, Eg., P. G. S., 1843, p. 184.
— *Higginsi*, Eg., M. G. S., Dec. 8, pl. 7, fig. 1.
— *leptocephalus*, Ag., P. F., tom. 2, feuil. 288.
— *pachysomus*, Eg. M. G. S., Dec. 6, pl. 4, fig. 1.
PHYLLODUS, Ag.
— *hexagonalis*, Cocchi, Pesch, Lab. Tav. 1, fig. 2.
— *irregularis*, Ag., Pesch. Lab. Tav. 3, figs. 7-7*a*.
— *planus*, Ag., Pesch. Lab. Tav. 1, figs. 4-4*a*.
— *polyodus*, Ag., Pesch. Lab. Tav. 3, figs. 8-8*a*.
PLATYGNATHUS, Ag.
— *paucidens*, Ag. P. F., V. G. R., tab. 28, fig. 11.
PLATYSOMUS, Ag.
— *striatus*, Ag., King. Perm. Foss., pl. 27. (*Counterpart.*)
PLEIONEMUS, Ag.
— *macrospondylus*, Ag. P. F. tom. 5, feuil. 52.
PLEURACANTHUS, Ag.
— *planus*, Ag. P. F., tom. 3, feuil. 177.
PRISTIS, Latham,
— *Hastingsiæ*, Ag., P. F,, tom. 3, feuil. 382*.
POLYPHRACTUS, Ag.
— *platycephalus*, Ag., P. F. V. G. R., tab. 31. fig. 5.

PTERICHTHYS, Ag.
— Paper Model, by Hugh Miller. J. G. S., vol. 4, p. 305, figs. 1-2,
— *cancriformis*, Ag., P. F. V. G. R., tab. 1, fig. 4.
— *cornutus*, Ag., P. F. V. G. R., tab. 2, fig. 4. (*Counterpart.*)
— ,, ,, P. F. V. G. R. tab. 2, fig. 5. (*Counterpart.*)
— *latus*, Ag., P. F. V. G. R., tab. 3, fig. 4.
— *macrocephalus*, Eg., J. G. S., vol. 18, pl. 3, fig. 7.
— *productus*, Ag., P. F. V. G. R., tab. 5, fig. 1.
— ,, ,, P. F. V. G. R,, tab. 5, fig. 2. (*Counterpart.*)
PTERYGOCEPHALUS, Ag.
— *paradoxus*, Ag., P. F., tom. 4, feuil. 192.
PTYCHOLEPIS, Ag.
— *minor*, Eg., M, G. S., Dec, 6, pl. 7.
PYCNODUS, Ag.
— *biserialis*, Ag., P. F., tom. 2, pt. 2, feuil. 199.
— *discoides*, Ag., P. F., tom. 2, pt. 2, feuil. 199.
— *obtusus*, Ag. P. F., tom. 2, pt. 2, feuil. 199.
— *parvus*, Ag., P. F., tom. 2, pt. 2, feuil. 199.
PYGÆUS, Ag.
— *Egertoni*, Ag., P. F., tom. 4, feuil. 257.
PYGOPTERUS, Ag.
— *latus*, Eg., King. Perm. Foss., pl. 24.
SCIÆNURUS, Ag.
— *Bowerbankii*, Ag., Rep. Brit. Ass., 1844, p. 307.
SCYLLIODUS, Ag.
— *antiquus*, Ag., P. F., tom. 3, tab. 38, fig. 1.
SEMIONOTUS, Ag,
— *minutus*, Eg. P. G. S., 1843, p. 183.
— *Pentlandi*, Eg,, P. G. S., 1843, p. 183.
— *pustulifer*, Eg., P. G. S., 1843, p. 183.
SPHÆRODUS, Ag.
— *rugulosus*, Eg., J. G. S., 1845, p. 167.
STROPHODUS, Ag.
— *reticulatus*, Ag., P. F., tom. 3, tab. 17.
TETRAGONOLEPIS, Ag.
— *dorsalis*, Ag. (DAPEDIUS), P. F., tom. 2, tab. 21*a*, fig. 1.
— *radiatus*, Ag. (ÆCHMODUS, Eg.), P. F., tom. 2, tab. 23*a*, fig. 2.

Works referred to in the foregoing Catalogue:
P. F. Recherches sur les Poissons Fossiles, par Louis Agassiz.
P. F. V. G. R. Poissons Fossiles du Vieux Gres Rouge, pâr Louis Agassiz.
M. G. S. Memoirs of the Geological Survey of Great Britain.
P. G. S. Proceedings of the Geological Society of London.
J. G. S. Journal of the Geological Society of London.
Rep. Brit. Ass. Reports of the British Association for the Advancement of Science.
King Perm. Foss. Palæontographical Society, Monograph of the Permian Fossils of England, by William King.
Pesch. Lab. Monographia dei Pharyngodopilidæ Studi Palæontologici del Del. Cav. Prof. Igino Cocchi, 1864.
Dixon, F. S. Fossils of the Tertiary and Cretaceous formations of Sussex, by Frederick Dixon.
Phil. Trans. Philosophical Transactions of the Royal Society.
Siluria. 2nd Edition by Sir Roderick Impey Murchison, Bt., K.C.B.

NOTICES OF MEMOIRS.

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Royal Commission on the Water Supply for the Metropolis. Report of the Commissioners. Presented to both Houses of Parliament by command of Her Majesty. London: Eyre and Spottiswoode. 1869. Fscap. pp. 128.

THIS important Report is now issued, and from it we extract the following:—

General Remarks on the Sources and Springs in the Thames Basin.
(pp. xxxv.–xl.)

It may now be well to review all the resources of the Thames basin before we proceed to consider the important question of the future water-supply of the Metropolis.

The drainage of the Thames valley above Kingston extends over 3,676 square miles; this area receives an average annual rainfall of about 27·2 inches, and one-third of the quantity due to this rainfall flows down the Thames at Hampton.

This delivery is the result of very complex conditions. One-third of the area consists of impermeable clays, and two-thirds (or about 2,450 square miles) of permeable Oolitic limestones, sands, and Chalk. From the former, the rainfall, after allowing for evaporation and for vegetation, flows off at once, and whenever in excess gives rise to floods, whereas the rainfall on the latter is at once stored up, and its ultimate delivery through springs to the streams and rivers is spread over weeks or months. To this cause is owing the permanence of flow of a river draining a permeable rock district, compared with the irregular delivery of a river draining an impermeable district, and it is a consideration of great importance in a question of water supply.

All permeable formations tend necessarily, by the absorption of rain, to become charged with water up to the level generally of the streams and rivers of the district; and further, owing to the resistance experienced by the rain water in passing through the strata, the water, wherever the ground rises above the level of the rivers, accumulates therein in proportion to the length, breadth, and height of the range of hills, so that instead of the line of underground water level presenting a flat surface between two valleys, it presents a curved surface varying according to certain conditions. Taking the lowest point of escape as determining the permanent level above which all the water tends to run off in springs, the height of the curve above this level gives the head of water on which the springs depend for their supply. The rise of the water being from the circumference of the hills to the centre, the underground reservoirs form more or less dome-shaped masses, the surface of which is constantly fluctuating in proportion to the difference between the amount of rain percolating through the strata and the quantity of water which escapes by the springs.

In the district we have to deal with, the crown of the curve often rises 50 to 200 feet or more above the permanent spring levels, while the actual height of the curve is known to vary in accordance with the variation in the rainfall, in many cases as much as 50 to 80 feet or more. Where the conditions are favourable to a large underground reservoir, the springs hardly ever run dry. Mr. Beardmore, as the result of many years' observations in the Chalk district of the Lea, sees reason to believe that the storing power of the Chalk hills there holds out at least 16 months.

Further, some of the water below the lines of permanent level inland has a slow underground movement to still lower levels, unless intercepted or thrown out by faults in the strata or by some other cause. This underground drainage is not, however, coincident with the surface drainage; and while some of the water-bearing strata of the Thames basin are not available as underground sources of supply by means of wells at or near London, other strata, on the contrary, out of the London basin, are so available from the circumstance of the dip of the beds being towards London.

Where the permeable strata only cap the hills the springs issue of course on the sides of the valleys at the junction of the impermeable strata.

In the order of superposition the highest permeable strata near London, excluding the superficial beds of gravel, are—

The *Bagshot Sands*, which are from 100 to 350 feet thick, and extend over an area of 211 square miles. As these strata consist almost entirely of loose quartzose sands, the underground water oozes out commonly at their junction with the London clay, and is rarely conducted into any particular channel of escape so as to form springs, and the loss by evaporation is large. There are, in fact, throughout this area no springs of any importance; only a few small tributaries of the Thames and the Wey have their sources in this district, and the supply to the wells is not large. The water generally is soft and pure, but in some places it is ferruginous. We cannot look to these sands for any additional water-supply (although they attracted a good deal of attention a few years since), for the whole of the water now delivered by them passes into the Thames or the Wey. None passes elsewhere underground.

The *London Clay* underlies the Bagshot Sands and forms a great impermeable bed from 400 to 450 feet thick.

Lower Tertiary Sands.—These beds, which are only from 50 to 100 feet thick, are of no importance so far as springs are concerned at their outcrop, but they have been useful sources of supply to some of the deep wells under London. Owing, however, to the great increase in the number of these wells, and the fall in the level of the water, the underlying Chalk is now generally resorted to as the better source of supply. In many places round London, where they have not been so drawn upon, they still yield a good supply of water.

The *Chalk*, from its large area (1,047 square miles above Kingston, but more than double that in the whole basin), from its great thickness—500 to 1,000 feet—and from its peculiar lithological character, forms a very important source of water-supply, both by springs and by means of wells. Almost all the rain falling on its surface is absorbed or percolates through the fissured surface. So close is its texture that the bulk of the rain takes weeks and months to filter down to the level of the water line in the interior of the Chalk hills—a line the depth of which below the surface of the ground may vary from 100 to 300 feet according to the height of the hills. The water thus stored escapes in several ways—some by the streams rising within the Chalk district,—some by springs feeding directly the larger rivers flowing through it,—another portion overflows at the outer escarpment of the Chalk,—and a larger portion issues near its junction with the Tertiary strata. A certain quantity also passes underground, supplies the wells, in the central Tertiary area, and escapes in part at still lower levels at more distant points.

Where the rise of the bottom of the valleys is more rapid than that of the line of water level, the valleys assume the character so common in Chalk districts, of dry valleys. Others of these valleys tap the springs in their lower part, whilst the upper part of the same valley is dry. In these cases the head of the stream will often change its position two or three miles higher or lower in the valley, accordingly as the rise and fall of the water level in the hills are influenced by the rainfall. Where the deeper and larger river valleys traverse the Chalk area and intersect the line of water level, these valleys become fringed on the river level with a series of springs, as the Thames in its course from Wallingford to Taplow, the Lea above Broxbourne, the Ravensbourne, the Cray, and the Darenth, and the Thames again from Woolwich to Gravesend.

The springs along the line of outcrop of the Chalk-marl and Gault being on a higher level than any others, the head of water supplying them is much smaller than that supplying the springs on lower levels within the Chalk area, and consequently with few exceptions these springs are small. They are, however, extremely numerous. Almost every little village under the range of the Chalk downs in Wiltshire, Oxfordshire, and further eastward, has its spring near the foot of the Chalk hills. These collectively would furnish a considerable quantity of water, but they are too scattered and wide apart to be available for any general purpose. There are, however, a few large springs amongst them. There is one, for example, at Cherhill, near Calne. This spring never fails, and is said to yield from two to three million gallons of water daily. There are also copious springs near Ellensborough, at Barton-in-the-Clay, near Prince's Risborough, near Swindon, and at many places along the foot of the North Downs of Kent and Surrey.

Another and more important class of springs are those which escape along the inner edge of the Chalk along or near the line where it passes under the Tertiary strata, and again where it approaches the sea level. These springs are all placed on relatively low levels, and derive their supplies from the large head of water which extends in the Chalk hills beyond them up to the outcrop of the beds underlying that formation. As the difference of level between these exterior and interior springs varies often from 150 to 300 feet, the latter are necessarily much more powerful and permanent, and will continue to run long after most of the others have become dry. Among the more copious and remarkable springs of this class are those at Chadwell near Ware, Otter's Pool near Watford, Froxfield near Hungerford, Beddington and Carshalton, Orpington, Grays Thurrock, Springhead near Gravesend, Ospringe near Faversham, besides a number of smaller ones. The origin and source of supply of some of these springs are indicated in the sections.

In the neighbourhood of London the wells in the Chalk form an important auxiliary source of water-supply, and they might, no doubt, be considerably increased in Kent without interfering with the springs in the valleys above London, as the store from which those wells draw their supplies overflows in numberless springs along the Thames below London at levels where they are not generally available.

The lower beds of the Chalk are so argillaceous as often to hold up the water and to lose their ordinary permeable character.

The *Upper Greensand* forms so much a part of the Lower Chalk, and is so slightly developed near London, that we have grouped it with the Chalk. It is only in Wiltshire that it acquires an importance entitling it to be considered apart. Under London it becomes also so argillaceous as to lose its water-bearing character.

The Upper and Lower Greensands are separated by 100 to 200 feet of impermeable clay, known as the *Gault*. The numerous small streams rising at the foot of the Chalk hills have their source generally in springs thrown out by the Chalk-marl, or the Gault.

The *Lower Greensands* form a mass of siliceous sandy strata from 200 to 500 feet thick, and with an available area of above 500 square miles. Cropping out both to the north and south of London conformably to the Chalk, which is known to pass below the Tertiary strata under London, it was supposed that the Lower Greensands were also continuous below London, in the same way as the Lower Greensands of the plains of Champagne pass under Paris at the depth of 1,800 feet. The experience, however, obtained at Kentish Town, at the deep well sunk through the Chalk a few years since by the Hampstead Company, showed that although the Tertiary strata, the Chalk, and the Gault followed in regular order, a change took place at the base of the Gault, and instead of the Lower Greensands, a series of red and grey sandstones were met with. These were bored into for a thickness of 188 feet, without passing through them, and the work was abandoned. No organic remains were discovered to indicate the age of these sandstones, and the hand-specimens were insufficient to determine the question. They may have belonged to some member of the New Red Sandstone, or possibly to the Old Red. In any case they seem to form part of an underground ridge of old Secondary or Palæozoic rocks which, ranging from Belgium, pass under the Chalk at Calais and Harwich, at both which places they have been met with, and probably extend under London in the direction of Somersetshire. The width of this belt can only be determined by experiment.

It is known that the Lower Greensands exist at Reigate and are about 450 feet thick, and that they occur again in Bedfordshire with a thickness of about 200 feet. In both cases they dip towards London, disappearing beneath the Gault. We know that they do not exist under London (Kentish Town). It follows, therefore, that in the one case they cease at some point between Reigate or Merstham and London, and in the other between Baldock and London. As at both ends they are of considerable thickness, and the Gault is continuous, it is certain that the Greensands must range from these outcrops some way towards London, probably thinning off gradually against the flanks of the underground ridge of old rocks. So far as they continue, so far will they form a valuable and copious water-bearing bed, the water from which would overflow at the levels lower than that of their outcrop. The extent of their underground range could only be determined by boring. It might be as far as Croydon, or even still nearer to London. The same would happen to the north of London, but the distance there is greater, the beds are not so thick, and the conditions generally are less favourable. The great purity of the water from the Grenelle and other artesian wells in the Lower Greensand is well known, and there is reason to suppose that the quality of the water obtained from the same formation in the vicinity of London would prove equally good. The excessive length of filtration would at all events ensure freedom from organic impurities.

The quality of the water flowing from the Lower Greensands is excellent for all domestic purposes, being bright and limpid, of a degree of hardness varying only from about 3° to 9° of Clark's test, and generally very free from organic matter.

The springs in this formation are not very numerous, owing to the prevalence of sandy beds, but in some of the more stony beds there are some fine springs, as for example:—

1. The springs in Bradbourne Park and at Riverhead near Sevenoaks.
2. Several springs near Dorking.
3. Spring at Weston Street.
4. Spring at Moorhead Park near Farnham.

To the south of London a great thickness of *Weald Clay* separates the Lower Greensand from the *Hastings Sand* of the Weald of Kent and Sussex; but although these beds are thick they are very local, only partially permeable, and are of no avail.

The strata which next succeed are only developed in the north and north-west of the London basin.

The *Portland Stone and Sands* are from 35 to 50 feet thick, and are, in some places, of local importance, but none of the springs would be available for distant purposes.

The *Kimmeridge Clay* is impermeable and from 250 to 300 feet thick.

The *Coral Rag* and *Calcareous Grit* are from 20 to 50 feet thick and give rise but to a few small springs. These beds thin off as they range to the east and south-east, so that in Buckinghamshire, and probably underground in Berkshire, the Kimmeridge and Oxford clays come into contact, and the Coral Rag ceases to exist.

The *Oxford Clay* is impermeable, and attains in Oxfordshire a thickness of 400 to 500 feet.

The *Great Oolite* and subordinate beds may for our purposes be taken together. They form in Oxfordshire an important group of permeable strata 250 to 300 feet thick. They have a collecting area of about 300 square miles, and give rise to a number of fine springs amongst which those of Ampney, Bibury, Boxwell, and Thames Head have been described by Mr. Bravender and Mr. Brown, and are stated by Mr. Pole to have been yielding at the time of his visit probably not less than 10 million gallons of water daily.

Most of the springs of this series are thrown out by the *Fullers Earth*, an impermeable bed of no great thickness in this district—40 to 60 feet—and persistent only over a limited part of the area.

The *Inferior Oolite* and underlying sands reposing on the Lias form another important water-bearing formation. They are from 300 to 320 feet thick, and extend in the Thames basin over about 180 square miles. As the hills of this formation rise 230 to 300 feet above the valleys, and have a considerable range, the head of underground water is large, and furnishes several important and perennial springs, such as those of Syreford and the Seven Springs, of which the yield is stated by Mr. Pole to have been at the time of his visit from three to four million gallons of water daily.

These various Oolitic strata consist of beds of rubbly limestones, soft freestones, sands and fissile sandstones, through which the water passes chiefly by fissures; and although often traversing a great thickness of strata, it is not filtered to the same extent as it is in the Chalk and Lower Greensands.

Mr. Hull has shown[1] that the Inferior Oolite and underlying sands which in the neighbourhood of Cheltenham are about 320 feet thick, thin off as they range eastward, and probably die out about the centre of Oxfordshire. In the same way he shows that the Great Oolite and accompanying beds, there about 300 feet thick, also thin to the eastward, and they apparently do not extend more than a few miles further east than the Inferior Oolite.

It follows that the underground passage of water through these Oolites, which might, had these formations ranged in full force eastward, have been carried as far as London, the dip being in that direction, is stopped by the thinning out of those beds, and by the closing in, as it were, of the Lias, Oxford Clay, and Kimmeridge Clay. Although, therefore, the surface drainage of the Cirencester and Bampton districts runs into the Thames valley, the subterranean water channels are intercepted and do not reach London, and the Oolitic series must be excluded as a possible source of supply by deep wells in the London district.

The exact proportion of the rainfall absorbed by the different permeable and porous strata, and which is given out again in the form of springs, has yet to be determined. It varies according to the lithological character of the water-bearing strata. The general results are, however, known in many cases. Thus the annual flow of the Thames at Hampton and of the Seine at Paris, both draining areas composed partly of permeable and partly of impermeable strata, is equal to about one-third of the rainfall. In a district where the impermeable strata predominate, the total deliveries will be larger, but they will follow close upon the rainfall; whereas, as the permeable strata predominate, so will the rainfall be stored in the hills, and its delivery be spread over a greater length of time. The summer flow in a dry season consists almost entirely of the supplies derived from deep-seated springs. Mr. J. T. Harrison, to whose evidence we would refer for many interesting details on these points, estimates this generally in the Thames district to be equal to one-sixth of the rainfall.

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[1] Quart. Journ. Geol. Soc. Vol. xvi. p. 63.

The importance of such a condition of things for the supply of this large Metropolis cannot be over-estimated. It ensures that permanence and regularity which are necessarily among the most important elements in a Metropolitan water supply. With natural subterranean reservoirs extending over above 2,000 square miles, a storage reserve is provided comparatively independent of the seasons, and maintained by the ordinary operations of nature, while no filtration can equal that effected through masses of sand, sandstone, earthy limestones, or chalk, from 50 to 300 feet thick. The quantity of mineral matter taken up is in most cases moderate, while the really objectionable ingredient—the organic matter—is reduced to a minimum. However different the results obtained in other cases, the two under-mentioned eminent chemists agree in their conclusions on this point, as will be seen by the following table, the quantities having reference in the first case to 100,000 parts, and in the second to a gallon of water:—

Sources of Waters Analysed.	Dr. Frankland.			Prof. Wanklyn
	Organic Carbon.	Organic Nitrogen.	Nitrogen as Nitrates and Nitrites.	Albuminoid Ammonia (representing the Organic matter containing Nitrogen).
Caterham Well (Chalk)	·020	·006	·027	0·000
Spring near Moor Park (Lower Greensand)	·030	·010	·045	—
Cold Harbour (Lower Greensand)	—	—	—	0·000
Otter Spring (Chalk)	·026	·012	·422	—
Loch Katrine	·256	·008	·031	0·130
Welsh Waters	·289	·004	·022	—
Cumberland Lakes	·211	·006	·009	—
Thames Water at Hampton	·260	·024	·192	0·134

At the same time the water is kept at a uniform low temperature, and protected from light and air, conditions unfavorable to the existence of living organisms. Springs from such sources probably represent potable waters in their best state; and amongst the favourable specimens of such waters may be instanced many Chalk springs, the water from the Lower Chalk at Caterham, and some of the springs of the Lower Greensands of Surrey.

It is satisfactory to know that there exists within easy reach of London a supply of the best and purest spring water which, in case of need, could readily be rendered available as an auxiliary source of water-supply for the Metropolis, in quantity sufficient at all events for drinking, if not for other purposes.

REVIEWS.

I.—The Mississippi Valley: its Physical Geography, including Sketches of the Topography, Botany, Climate, Geology, and Mineral Resources; and of the progress of development in population and material wealth. By J. W. Foster, LL.D. Illustrated by maps and sections. Chicago: S. C. Griggs & Co. London: Trübner & Co. 1869. 8vo. pp. 444.

THE author, having devoted many years to the exploration of the Mississippi valley, describes in the volume before us the physical geography of that portion of this wonderful region which lies west of the great dividing line—the Mississippi River.

It was with a view of illustrating the gradations between the forest, prairie, and desert; the varying conditions of temperature and moisture, and their effects in determining the range of those plants cultivated for food; and, at the same time, to trace the character of the fundamental rocks over the whole of this region, pointing out the mode of occurrence of those ores and minerals useful in the arts, and, finally, to trace the colonization of this region from its feeble beginnings to its present magnificent proportions, that this work was undertaken by Dr. Foster.

It is not intended to be a strictly scientific work, but rather to present a series of sketches of the great phenomena of the region under consideration in a form which should at once interest and instruct the general reader.

Among the many chapters calculated to interest the general reader there are some which may be considered as more especially attractive to the physicist and geologist. Of these we might mention, firstly, the chapters in which the author discusses the origin of prairies, including not only those of the great Mississippi basin but also those of South America and other countries.

Dr. Foster discusses the various views put forth by other authors as to their origin, whether as due to peat-growth, texture of soil, or annual burnings; and concludes, after a careful consideration of all the conditions, that "a study of the physical features of the country in connection with the prevailing winds, the consequent distribution of moisture, and also the lines of equal temperature, will show—firstly, that these great changes in the geographical distribution of plants, under nearly equal lines of temperature, are not due to the mechanical texture or chemical composition of the soil, but to the variable supplies of moisture; secondly, that in the winds, as the agents in the distribution of that moisture, we have an adequate cause to explain all the phenomena of forest, prairie, and desert."

Turning now to the geological structure of the valley, the basin consists for the most part of nearly horizontal and but little metamorphosed strata, such as limestones, sandstones, shales, and detrital materials bounded by granitic or highly metamorphosed rocks, which have at many points been invaded by products of a purely volcanic origin.

It is chiefly in this latter series that the precious as well as the baser metals occur, either segregated as veins or as beds or layers. Not that they are entirely confined to this series, for the stratified rocks, as the limestones and shales, contain also the useful ores, such as iron, lead, and zinc, as well as immense deposits of fossil fuel extending over vast areas.

The author gives (at p. 246) a tabular view of the principal Fossiliferous strata of the Mississippi Valley and Pacific slope, in which local terms are given for the sub-divisions of the groups. Thus, for example, in the Carboniferous series we have in descending order—1. Coal-measures; 2. Chester Limestone; 3. St. Louis group; 4. Keokuk group; 5. Burlington Limestone; 6. Kinderhook group; which vary from 800 to 1400 feet in thickness *exclusive* of the Coal-measures.

The Burlington Limestone is celebrated, more especially in Illinois, for the beauty and profusion of its Crinoids. Mr. Worthen (Geologist to the State of Illinois) writes, "No spot has yet been discovered on the surface of the earth, of the same extent, where those beautiful 'lily-stars' flourished in such numbers, as along the northern shores of the Sub-Carboniferous ocean during the deposit of this limestone. More than 300 species have been already described from this region."

The vast area in the great valley over which the Coal-measures are distributed is divided into several distinct fields, intersected by navigable waters, by which their products are conveyed to the great emporiums of industry.

The Alleghany Coal-field ranges through six different States, and has an estimated area of 60,000 square miles. The shales, limestones, etc., have a thickness of 2,500 to 3,000 feet. The workable coal-seams at Pittsburgh have an aggregate thickness of 25½ feet, and in Southern Ohio of 22½ feet.

The Illinois Coal-field is, in area, about equal to the Alleghany Coal-field. The Coal-measures in this field have a thickness of 800 feet, and the workable coal in Southern Illinois is 19 feet in thickness.

The Missouri Coal-field has the largest area of any field in the world, being not less than 100,000 square miles in extent. In Kansas the series is two thousand feet in thickness, and contains from 12 to 15 feet of workable coal.

The Michigan Coal-field has an area of 5,000 square miles, and a thickness of 100 feet only.

The Texas Coal-field has only been very imperfectly explored, and neither its extent or thickness are correctly known.

The coals derived from these various fields, and even from different seams, are far from uniform in character. The most valuable coals perhaps, thus far developed, are those of Northern Ohio and North-western Pennsylvania derived from the lowest seam in the series. This forms an admirable coal for iron-making. A similarly valuable coal occurs in the Illinois Coal-field.

The Pittsburgh Coal, and that of Central and Southern Ohio, make good coking coal, but are too gaseous and bituminous for iron-making. The coal of Northern Illinois is too sulphurous and too highly charged with water to be of great commercial value.

Tables of Analyses of all the various coals, including those of Secondary and Tertiary age, have been carefully prepared by the author from the various reports of Blaney, Whitney, Chilton, Rogers, &c., &c.

The space at our command precludes our noticing, as we should wish to do, the geological features of the valley which are due to the later formations.

There is much in this work for the Botanist, the Archæologist, the Meteorologist, for the political Economist, for the general Naturalist, and for the reading public. Few American books which have passed through our hands have interested us so much. The author's style of writing is extremely clear and intelligible. Whenever an illustration would better explain his meaning than a mere description, we find a map, a plan; or a diagram added. Lastly, the book is admirably printed, which renders its perusal all the more pleasant.

II.—Geological Tables.

TO enumerate all the separate Geological Tables published by amateurs and professionals from the times of Werner, W. Smith, Alex. Brongniart, and De la Beche, to the present, would be of little use except to the bibliographist; and the many tables of strata and formations given in the Manuals and other introductory works on Geology, English and Foreign, would have to be catalogued also in the lengthy list. We propose, however, to refer to some of the Tables that have appeared of late years, and to notice their respective characters and uses.

There is no doubt that English geologists owe very much, in the first place, to De la Beche, for original observation, careful research, and correct judgment, in the composition of classificatory tables, which, founded on the conclusions of Werner, Smith, Conybeare, Brongniart, and others, supplied *data* for subsequent writers. Lyell and John Phillips also, as classificatory geologists, contemporary with De la Beche, gave original thought to the subject; and their continued labours have given us the results which we now find in their current works; and these, especially the Tables in Lyell's "Elements," supply the manualists and tabulists of popular and educational geology with the backbone, if not the body, of all their Tables of Formations.

We must not forget, however, that there have been many other original thinkers and hard workers besides those mentioned above. Sedgwick, Murchison, and very many other well-known names are quickly thought of in connection with the advance of stratigraphical geology; and America, and every part of the Continent, as well as India and the Colonies, have supplied others, the results of whose labours, as far as it concerns the Palæozoic formations, have been brought together for English readers by Murchison in his "Siluria;" whilst Prestwich and Lyell are chief among those who have collated the works illustrative of the Tertiary groups of strata and fossils; and for the Secondary Formations, we have, besides our home geologists, Phillips, Fitton, Mantell, Strickland, Morris, Wright, etc., numerous good German and French guides, as Fraas, Oppel, Geinitz, Alberti, Marcou, Hébert, Coquand, D'Archiac, etc., in correlating and enumerating their manifold and various groups.

There are some, especially Constant Prevost and Godwin-Austen, who have greatly influenced the character of geological tables, by insisting on the importance of clearly defining the categorical value of the marine and the freshwater deposits respectively, as direct indications of the existence of land and of sea, whether in vertical succession or in horizontal continuity. This idea is prominent and well illustrated in a table produced by Prof. W. King, and entitled "Synoptical Table of Aqueous Rock-groups," etc. (fifth edition, Belmont, near Galway, July, 1863), the marine strata being arranged in a parallel column with those of land and freshwater origin.

Students were long ago indebted to Webster and Buckland for an elaborate diagrammatic section of a portion of the Earth's crust, with figures of animals and plants characteristic of the three great periods of the Earth's history, as then known. Without the palæontological figures, this section has been for many years among the most saleable of the geological diagrams issued by Reynolds (Strand), and by the Working Men's Association (King William Street). However much improved Mr. Reynolds's editions of this diagram have been by the introduction of perspective country, and by Prof. Morris's amendments, it still wants a proper treatment of the "metamorphic" rocks, so called, which are really the crumpled and altered Laurentian and other strata, there being properly no metamorphic formation or system by itself. The same weakness is present in Readwin's "Tabular View," etc. (1858, Reynolds & Co., Old Broad Street), and even in Morris's "Geological Chart" (new edition, 1868, Reynolds, Strand), which is one of the best of Geological Synopses, as it shows at one view the order of succession of the stratified rocks, with their mineral characters, principal fossils, average thickness, localities, and uses in the arts. These points are also aimed at in Readwin's smaller Tabular View of the arrangement of British Rocks, etc., above mentioned. In the still later "Geological Table," by W. Parsons (Stanford, Charing Cross), the British fossiliferous strata and their characteristic fossils (genera and species, as in Morris's Chart), are enumerated, and some miscellaneous remarks on each group, chiefly compiled from Lyell and Murchison, are given in a parallel column.

Charts and tables, illustrated by figures of fossils, grouped according to their geological occurrence, are much in request with many students. Such a table we have already referred to as having been published in Buckland's "Bridgewater Treatise" (1836). Another was issued with D'Orbigny and Gente's "Géologie appliquée," etc., 1855; but the best are those by Nérée Boubée (Paris) and J. Lowry

(London), both of which are of considerable size and well executed; the latter contains besides a carefully arranged column of formations, a column of lithological remarks, and very numerous well chosen and well engraved figures of characteristic fossils. Messrs. Lowry and Etheridge's later Chart of the Tertiary fossils (Stanford, London), is a further and excellent adaptation of the same plan to a separate stratigraphical system.

By making the Organic Remains the chief objects of a geological table, and setting one class, or order, in its manifold developments, to indicate the successive stages of deposits, several very useful charts may be constructed besides the one of Crustacea by Salter and Woodward, already published by J. Lowry (London, 1865), and well known to geologists.

The gradual working-out of British geology in the field, by the Geological Survey of the United Kingdom, has necessarily been a most important element in the growth of true stratigraphy, proving and knitting together all that is good in the observations and deductions of the earlier geologists and of contemporaries, and bringing out in maps and memoirs the perfected lists of strata and fossils of district after district. A generalized catalogue of the British formations is therefore to be found in the Explanatory Table of the Colours of the Geological Survey Maps of England, Scotland, and Ireland, as well as in the Tabular View of the Aqueous and Fossiliferous Rocks of Britain in the preface (p. lxxviii) of the "Catalogue of the Collection of Fossils in the Museum of Practical Geology," 1865, whilst the fossils of the groups are enumerated (but not in a consecutive order) in this "Catalogue."

Of course, foreign Geological Surveys aid in the collation of the strata of different countries; but this is a very extensive subject, and belongs to special memoirs rather than to general tables.

If by the foregoing remarks we have aided the student in finding such geological tables as he requires, and have indicated how the existing tables may be improved and multiplied, our aim is reached.

T. R. J.

III.—GEOLOGICAL SURVEY OF ILLINOIS. A. H. Worthen, Director.
Vol. I. Geology. 4to. 1866, pp. 504, with eleven maps and engravings. Assistants: Professor J. D. Whitney, Professor Leo Lesquereux, and Mr. Henry Englemann.
Vol. II. Palæontology. 4to. 1866, pp. 470, with 50 plates. Vertebrata: MM. J. S. Newberry and A. H. Worthen.—Invertebrata: MM. F. B. Meek and A. H. Worthen.—Plants: M. Leo Lesquereux.
Vol. III. Geology and Palæontology. 4to. 1866, pp. 574, with 20 plates.—Geology: MM. A. H. Worthen, H. Englemann, H. C. Freeman, and H. M. Bannister.—Palæontology by MM. F. B. Meek and A. H. Worthen.—Published by authority of the Legislature of Illinois.—London: Trübner & Co.

FOLLOWING the example of the State of New York, the Legislature of Illinois, in 1851, passed an Act authorizing a Geological

Survey of the State. The work was commenced, but until after Mr. Worthen's appointment in 1858 no reports appear to have been made.

The admirable manner in which the three large volumes have been prepared, within ten years of the appointment of the present Director, reflects the highest credit upon Mr. Worthen and his assistants, and the authors' work may fairly rank side by side with that of the veteran State Geologist of New York, Mr. James Hall, whose greater labours have extended over a far longer period.

The State of Illinois embraces a geographical area of about 55,400 square miles, and is bounded on the north by the State of Wisconsin, on the east by Lake Michigan, the State of Indiana, and the Wabash River, on the south by the Ohio, and on the west by the Mississippi. For nearly three-fourths of its entire circumference it is bounded by navigable waters, which afford facilities for the cheap transport of its products equalled by few of the neighbouring States and surpassed by none.

The slope of the watershed is mostly to the south-west, and nearly all the principal streams after a general course in that direction empty into the Mississippi. The face of the country is generally level or gently rolling, but along its northern limits, between Freeport and Galena, the elevations known as the "Mounds" attain a height of 1150 feet above the sea. These mound-like elevations are very common on the prairies in some portion of the State, and appear to be "outliers" resulting from the denudation of the original surface. In the southern portion of the State, on the contrary, a mountain ridge exists, which has resulted from the dislocation and upheaval of the strata from beneath forming an axis of elevation.

Of the different Geological systems, only the following are represented in Illinois, namely, Quaternary, Tertiary, Carboniferous, Devonian, and Silurian; thus the Cretaceous, Jurassic, and Triassic formations have here no representatives, and it is not improbable that the entire area was above the ocean level during these epochs.

A section is devoted to Surface-Geology, including the Drift, Loess, and Alluvial Deposits, followed by a chapter on Tertiary Deposits and Coal-measures, from which it appears that the Coal-bearing strata cover more than two-thirds of the surface of the State. The lower coal-seams are restricted to the central and southern portions of the State, while the upper seams extend to the northern confines, and are the ones mainly to be relied on in that part for the supply of coal.

This distribution of Coal-measures appears to have resulted from a gradual subsidence of the entire surface of the Illinois Coal-field during the Coal-era, from which cause each succeeding division of the Coal-measures was extended in a northerly direction, so as to cover a larger area in that direction than the one which had preceded it. Prof. Lesquereux devotes a chapter to the consideration of the formation of Coal and its distribution in all the various Coal-fields of Illinois. By the same author is an admirable chapter on the Origin and Formation of Prairies, the chief facts of which were published by him in 1857.

Prof. Lesquereux has further enhanced the value of these volumes by his able Report (in vol. ii.) on the Fossil Plants of Illinois, occupying 40 pages of letterpress and illustrated by 17 well-executed plates. In the same volume are descriptions of the *Vertebrata* by Messrs. J. S. Newberry and A. H. Worthen; and of the *Invertebrata* by Messrs. F. B. Meek and A. H. Worthen.

Among the *Echinodermata*, as might be expected from the known richness of this region, are many new and remarkable forms. There is a most wonderful Crinoid; placed near the *Gilbertsocrinus* of Phillips, and named *Goniasteroidocrinus* (=*Trematocrinus* of Hall), certainly the most anomalous form of Crinoid (if such it be) which we have seen. In addition to five bifurcated processes (supposed by Phillips and others to be the arms), it appears to have true arms superadded to these, placed in the interspaces between the five thick bifurcated arms, which are considered to be equivalent to the side-branches of the column of *Pentacrinus*. Many new forms of *Crustacea*, *Arachnida*, and *Myriapoda*, are added to the fauna of the Coal-period, they include *Eurypterus Mazonensis*, M. and W. from Mazon Creek, Grundy Co. Illinois; a new *Limulus* (*Bellinurus Danæ*), a new Macruran Decapod (*Anthrapalæmon gracilis*); *Palæocaris typus* (referred by Messrs. Meek and Worthen to the *Decapoda-Macrura*, but resembling more nearly the *Isopoda-aberrantia*), one of those debateable forms which, like *Gampsonyx fimbriatus*, from the Permian of Saarbruck, can only be explained on the Darwinian hypothesis. *Acanthotelson Stimpsoni*, M. and W. and *A. Eveni*, M. and W. two admitted species of Isopods.

Among the Bivalved *Entomostraca*, *Ceratiocaris?* *sinuatus* M. and W., and *Leaia tricarinata*, M. and W. may be mentioned.

In the *Myriapoda*, *Euphoberia armigera* M. and W., a huge Centipede, and *E. major*, M. and W., even larger.

Eoscorpius carbonarius, M. and W., a new Coal-measure, Scorpion and *Mazonia Woodiana*, M. and W., a still more interesting form of Arachnide.

Several species of true Insects: *Miamia Danæ*, *Chrestotes lapidea*, *Mantis*, ? *Meganthentomum pustulatum*, *Euphemerites simplex*, *E. gigas*, and *E. affinis*, have been identified by Mr. Samuel H. Scudder, of Boston, from the Coal-measures of Illinois.

We cannot do justice in our limited space to this admirable Report, nor give any detailed account of the careful way in which, county by county, the region has been traversed and worked out by Mr. Worthen and his colleagues.

Numerous maps, sections, plates, and woodcuts, illustrate both the Geology and Palæontology of the State, and reflect the highest credit on the artists and draughtsmen employed in their execution.

REPORTS AND PROCEEDINGS.

GEOLOGICAL EXCURSION TO HUNSTANTON.—The members of the Geologists' Association, accompanied by Professor J. Morris, F.G.S., visited Hunstanton, Norfolk, on August 2nd, for the purpose of examining the interesting geological features of this locality.

Hunstanton Cliff, or St. Edmund's Hill, although of moderate elevation and extent, forms, from the comparative flatness of the adjacent country, a somewhat conspicuous object, and from the three distinctly marked coloured strata (white, red, and brown) of which it is composed, has, when viewed from the north-eastern end, a very picturesque appearance. At the highest part of the cliff about 60 or 70 feet above the shore, and near the ruins of the ancient chapel, stands the lighthouse, the houses of the old village being rather more inland. This cliff, which forms the north-western point of Norfolk, and, bordering the Wash, consists of Cretaceous strata which re-appear on the opposite coast of Lincolnshire, with which they were, doubtless, once continuous, although now widely separated by the modern estuary, from the most conspicuous stratum—the White Chalk—with an average breadth of about six miles, can be traced from Flamborough Head, trending for some miles westward, forming hills with a northerly escarpment, which range of hills, bearing suddenly round in a south-easterly direction, form the Wolds of Yorkshire. South of the Humber the Chalk rises again into another hilly range—the Lincolnshire Wolds—and terminates at Burgh, south of which it is lost beneath the alluvial land of the easternmost part of the county. Reappearing at Hunstanton, the Chalk forms a ridge of hills, running nearly south towards Castle Acre and Swaffham, near to which it becomes again partly obscured by superficial deposits.

The section of the cliff, about a mile in length, exposed along the shore, which was the chief object of the visit of the Association, has been long one of interest to geologists, from the particular development of the stratum termed the "Red Chalk"—a bed which has been traced in a corresponding position in some parts of Lincolnshire, as near Louth and Tealby, but only again exposed in a sea-cliff section near Speeton, on the Yorkshire coast, where, however, it attains a thickness of 30 feet, while at Hunstanton it is only 4 feet. From the latter place the outcrop of this bed can be traced to Sandringham, eight miles southwards.

Many notices have been published of this section, from that of Mr. R. C. Taylor, in 1823, or even previously by Conybeare and Phillips, to the paper by the Rev. T. Wiltshire in 1869, and particularly by Dr. Fitton, in the Geological Transactions for 1836, who cites the previous writers, and the result of his own observations 10 years before. The Red Chalk has always been a special object of investigation, with a view of determining its true position in the geological scale, or of which of the Cretaceous beds in the Southern Counties it is the equivalent, for it has been considered to represent the Gault, the Upper Greensand, or even both these formations, and was believed by Mr. Samuel Woodward (Geology of Norfolk, 1833, p. 30) to be identical with the "Chalk with quartz grains" noticed by De la Beche as occurring near Lyme Regis.

The strata of the cliff consist in descending order of White Chalk, *Red Chalk*, brown and dark coloured ferruginous sands and coarse grits, the white chalky beds attaining their greatest thickness in the cliff under the lighthouse. Commencing at the south-west point, where the cliff rises from the lower ground, the attention of the party was first directed to the bed of drift-clay, containing pebbles and boulders of different rocks, as dolerite, limestone, flint, Red Chalk, etc., abutting against and overlying the ferruginous rock for a short distance. This latter rock, which forms the base of the cliff, is known to repose upon the Kimmeridge clay below, which however is not very frequently visible. This ferruginous rock, from the slight inclination of the strata, and the denudation to which the district has been subjected, forms the cliff for some distance; it is about 30 ft. thick, and consists in its upper part of rather incoherent sandstone, with small pebbles and bands, or veins of ironstone: the lower part is more dark-coloured and coarser grained, the pebbles being of larger size, and united by ferruginous matter. Throughout this bed are many grains, of variable size, of hydrated peroxide of iron, occasionally pisolitic, with titaniferous iron ore, sometimes magnetic, and to which, as well as their decomposition, the colour of the rock is due. This part is traversed by fissures, and divided into oblong blocks, with a hard ferruginous outer coating, and with a grey or green interior. This hardened bed forms the floor of the shore for some distance, and partially protects it. It also forms pillars in the cliff (owing to the eroding action of the sea), which support the upper beds. No fossils have been found in the upper portion of this sandstone, but a line of nodules near the base have yielded *Ammonites Deshayesi*, *Am. Cornuelianus*, *Perna Mulleti*, and other species characteristic of the base of the Lower Greensand, and which are considered by Mr. Wiltshire to be in place, and by Mr. Judd to be derived from the disintegration of Lower Neocomian strata, like the deposits with phosphatic nodules at Potton and Upware.

The indurated ironstone is known as Carstone in Norfolk, and is largely used for building, as may be seen in the new houses at Hunstanton, and the farm and other buildings elsewhere. The late Mr. S. Woodward mentions that it was also used for "querns," or corn-mills (Geology Norfolk, 1833, p. 30). The iron grains are abundant, but not used here economically, although workable iron ore is obtained from the same formation near Tealby and Caistor, in Lincolnshire, and at Seend, in Wiltshire. Remains, however, of the products of old furnaces where iron-smelting had been carried on, have been observed in several localities in the northern part of Norfolk.

These disintegrated iron grains, from their weight, are separated by the wind from the lighter particles, and form darker patches here and there on the sands of the shore. Overlying these sands, and separated from them by a thin incoherent bed, comes the Red Chalk, about four feet thick, abounding in rolled and subangular pebbles of quartz and other rocks, and containing many fossils, of which the most abundant are *Terebratula biplicata*, *Belemnites attenuatus*, *B. minimus*, *Ammonites auritus*, and *A. lautus*, with fifty other species, the upper part being much harder than the lower, and the colour somewhat unequally distributed, but sometimes so deep coloured that the bed has been ground and used for paint. The origin of this colour, whether due to original deposition, or subsequently derived by segregation from the bed below, is a point of interest.

Above the Red Chalk succeeds another chalk bed about one foot thick, supposed to be equivalent to the Malm rock of Sussex, containing many branched sponges as *Spongia paradoxica*, with *Avicula gryphæoides*, *Kingena lima*, and other species; this is covered by other beds of Chalk, of which the lowest, about two feet six inches thick, is remarkable for the abundance of fragments of *Inocerami* dispersed throughout it (with other fossils, as *Ter. gracilis*, *T. semiglobosa*, and *Holaster planus*), and which give it a very irregular surface when weathered. By the inclination of the strata before noticed, these latter beds come to the shore at the north end of the cliff. The trend of the coast, partly modified by an angular projection, does not exactly coincide with the direction of the dip, which is very slight towards the north-east. It is to this arrangement, (due to some original movement and subsequent denudation), that the strata successively crop out in a south-easterly direction, and the general form of the country has been produced. The face of the cliff varies continually, owing to the falls which frequently take place, a considerable one having lately occurred, so that during the last fifty or sixty years many acres have been removed, owing to the action of the sea against the cliff, together with the effects of rain and frost on the adjacent surface of the land.

Altogether this section is interesting to the geological student, not only as showing the nature of these old sea-beds, their mode of accumulation, the effects of currents, and the difference of condition, when compared with other areas of contemporary deposition, but the modifications they have subsequently undergone by chemical and other agencies, and the general effects of the later operations in producing the surface features of the country.

OBITUARY.

THE LATE PROFESSOR J. BEETE JUKES, M.A., F.R.S., ETC.—It is our melancholy task to record the death of one of the most distinguished students of Natural History—a pioneer in Geological Science—an undaunted investigator of the truths of Nature. We can recall the massive form, the penetrating glance, and sturdy step of our late friend, as many years ago we accompanied him amongst the mountains of North Wales, and had the advantage of his instruction when attempting to unravel the intricate structure of their rocks. How hard it is to realise that that head is now laid at rest in a quiet churchyard of central England! As a last tribute of respect to his memory, and in grateful remembrance of many acts of kindness, we venture to place on record the following short account of the late Mr. Jukes' eventful life.

J. Beete Jukes was born near Birmingham on the 10th of October, 1811, and educated at King Edwards' School in that town, whence he proceeded to St. John's College, Cambridge, where he took his degree of B.A. in 1836. It was here, we believe, that, under the teaching of Professor Sedgwick (whom he ever regarded with feelings of veneration, and with whom he was a favourite pupil), he imbibed a love for his chosen science, which he soon after applied in a Geological Survey of Charnwood Forest, in Leicestershire, and the surrounding country.

Early in 1839 he was appointed Geological Surveyor of the Colony of Newfoundland, and has recorded the results of his labours in a work on the Geology of that country, accompanied by a map and illustrations. Shortly after his return to England in 1841, Mr. Jukes was appointed by the Admiralty to the post of Naturalist on board H. M. Ship "Fly," commanded by Captain E. P. Blackwood, R.N., for the Survey of the Coast of Australia and New Guinea, and had opportunities, which he turned to good account in after life, of becoming acquainted with the nature and mode of formation of Coral Reefs, and their relations to the limestones of former Geological periods. The results of this exploration are detailed in "The Voyage of H. M. Ship Fly." The good ship returned to England in June, 1846, and in September of that year Mr. Jukes was appointed to the staff of the Geological Survey of Great Britain, of which Professor A. C. Ramsay was Director, and Sir H. T. De la Beche, Director-General. At that time the Survey was being carried on in North Wales, and Mr. Jukes was associated with Ramsay, Aveline, and the late Mr. Salter, as Palæontologist, in the production of those maps and sections which have justly drawn forth the admiration of all who have studied them, for the minuteness and fidelity with which they illustrate the structure of a broken and mountainous country, complicated by numerous flexures, the outflow of trap-rocks, and often traversed by enormous dislocations. On the completion of the Survey in Wales, Mr. Jukes undertook that of the South Staffordshire Coal-field and the adjacent country. His memoir on the Geology of the South Staffordshire Coal-field is one of the most valuable contributions to the literature of the Carboniferous Rocks of England. In 1850 he was appointed by Sir R. I. Murchison to the post of Director of the Geological Survey of Ireland, vacant on the appointment of Professor Oldham to the Survey of India; and in 1854 to the Lectureship of Geology in the Royal College of Science in Dublin, under Sir Robert Kane.

In his capacity of Director, Mr. Jukes applied himself with all his energies to the duties before him; and with the assistance of (till recently) a small staff of Surveyors—of whom the lamented Mr. Du Noyer and Messrs. G. H. Kinahan, F. J. Foot, J. O'Kelly, R. G. Symes, and W. H. Baily, as Palæontologist, were the principal—he completed the Survey of about one-half the superficial area of Ireland, together with the editing and partial authorship of about 42 explanatory Memoirs on the Geology of the country.

During this period Mr. Jukes did not neglect investigations of a more private character, tending to elucidate the structure and the relations of the rocks of England and Ireland. His researches in

Devonshire, and his attempts, in spite of much difficulty, to answer the question "how far is it correct to call any Old Red Sandstone by the name of Devonian, or to consider any part of it as contemporaneous with the rocks containing marine fossils, to which that designation is fairly applicable,"[1] will long be remembered; and has a melancholy interest, as there is some reason to think that the overstraining of his mental powers in consequence of this and other labours engaged in at this period, tended to accelerate the progress of the disease to which he subsequently succumbed.

One of the most valuable works which Professor Jukes completed, was the publication of "The Students Manual of Geology," which was soon followed in 1862 by a second and enlarged Edition. We venture to think that all who have had occasion to use it will readily admit that this is a most useful work of reference. The author was engaged at the time of his death in the preparation of a new Edition, and it is to be hoped that some trustworthy hand will carry out his intentions, and render the pages of this manual in accordance with the ever varying progress of our Science.

One of the last public acts of Mr. Jukes was to accept an appointment on the Royal Coal Commission, instituted by Parliament with the object of determining the possible resources of our Coal-fields and kindred questions. Mr. Jukes' knowledge of the structure of some of the central portions of England was here brought into requisition, but his researches into the resources of the Irish Coal-fields seem to have been terminated by failing health. This, however, is less to be regretted, as we are well aware that the productive Coal-fields of this country are altogether unimportant as bearing on the general question.

While the career of the late Professor Jukes should be an example and encouragement to students in Science, it should also have the effect of making them guard against the tendency of this impetuous age—to overtask the brain. This impulse permeates more or less all society, but especially men of letters, and cultivators of Science. It is only given to a privileged few, of great intellect and all-enduring brain, to withstand the wear and tear of an intellectual course. The result in most cases may be a rapid rise to distinction, and the acquisition of a vast amount of knowledge; but it is dearly bought if it curtails, by even a few short years, a life endeared to friendship, and useful to society. E. H.

We regret that we have also to record the death of one of the ablest Palæontologists of the present age—Mr. JOHN WILLIAM SALTER, A.L.S., F.G.S. (late Palæontologist to the Geological Survey of Great Britain), whose life of active labour in this department of Science was sadly terminated on 2nd August, 1869. We hope to give a suitable notice of his labours in our October number.—EDIT.

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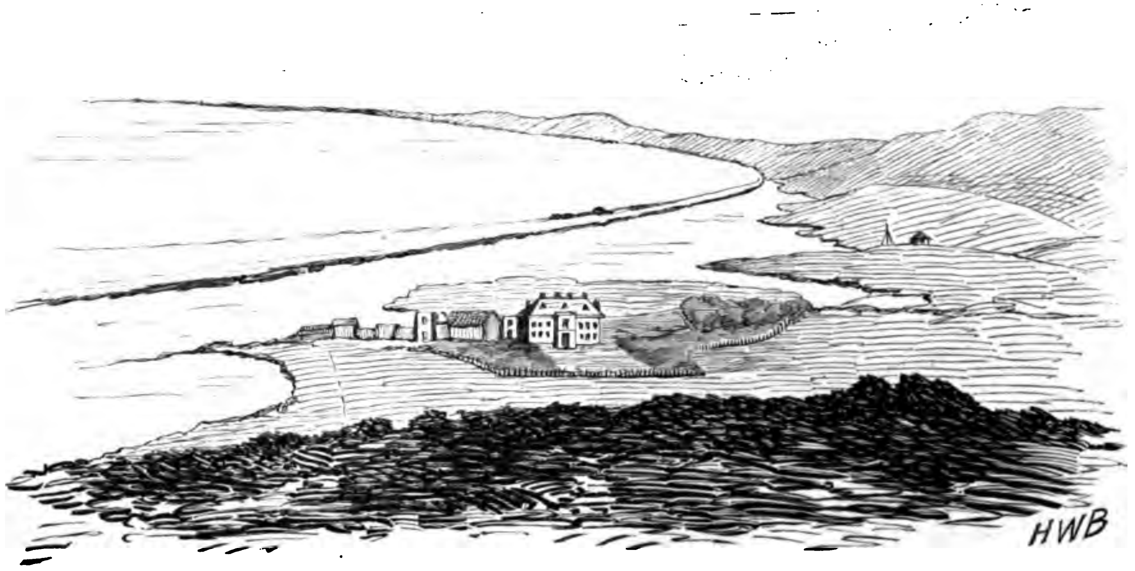
[1] "On the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon." Quart. Journ. Geol. Soc. 1866, Vol. xxii. p. 320. "Additional Notes on the Grouping of Rocks in North Devon and West Somerset." (Printed and published separately.) Dublin, 1867. And "Notes on Parts of South Devon and Cornwall," etc. etc. (Published separately for the author.) Dublin, 1868.



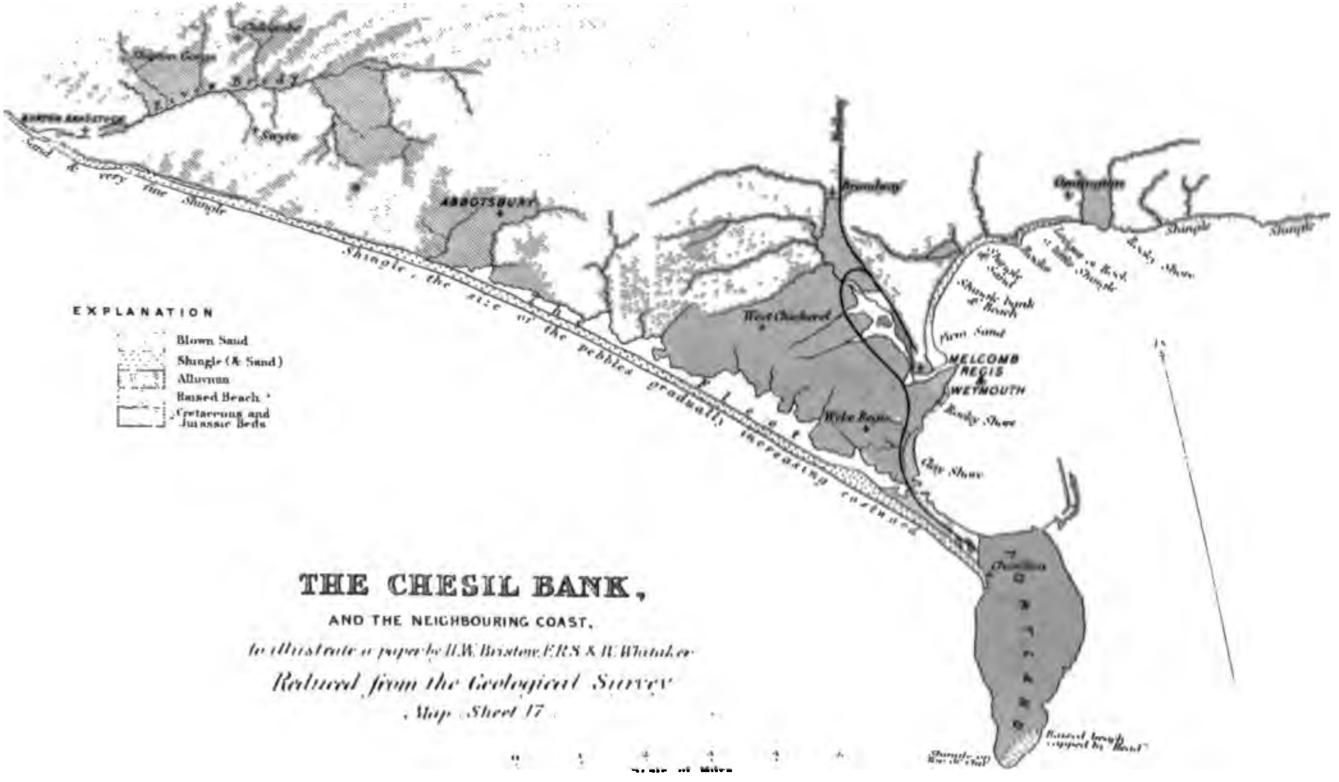
From a Sketch by H. W. Bristow, 1849. *Drawn and Engraved by G. R. De Wilde.*

VIEW OF THE CHESIL BANK AND THE "FLEET" OR "BACKWATER,"

Looking westward from near Fleet House.

[To illustrate Messrs. Bristow and Whitaker's paper on the formation of the Chesil Bank].

PLATE VII.



THE CHESIL BANK,
AND THE NEIGHBOURING COAST,
to illustrate a paper by H.W. Bristow, F.R.S. & W. Whitaker.
Reduced from the Geological Survey
Map Sheet 17.

THE
GEOLOGICAL MAGAZINE.

No. LXIV.—OCTOBER, 1869.

ORIGINAL ARTICLES.

I.—On the Formation of the Chesil Bank, Dorset.

By Henry William Bristow, F.R.S., F.G.S., and William Whitaker, B.A. (Lond.), F.G.S., both of the Geological Survey of England.

[PLATES XIV. & XV.]

[A Paper read before the Geological Society of London, May 26, 1869.]

> * * * * "Aloft where *Chesill*, lifts
> Her ridged snake-like sands, in wrecks and smouldring drifts,
> Which, by the South-wind raysd, are heav'd on little hills:
> Whose valleys with his flowes when foming *Neptune* fills,
> Vpon a thousand swannes the naked Sea-Nymphes ride
> Within the ouzie Pooles, replenisht euery Tide:
> Which running on, the Isle of *Portland* pointeth out."
> *Poly-olbion*, by Michael Drayton, Esq., Fol., Lond., 1613, p. 24.[1]

We do not propose to enter into the questions of the source whence the pebbles of the Chesil Beach are derived, nor of the way in which they are heaped up; these and other like matters having been almost exhaustively treated by Mr. J. Coode,[2] to whose paper we refer the reader for a detailed account of the bank. The subject with which we propose to deal is simply the cause of the formation of a long shingle-bank, separated from the mainland by a strip of water. This has not been noticed at length by any writer, as far as we know, though three theories of the origin of the bank have been brought forward.

Sir Henry De la Beche is the author of one of these. He says: "It (the Chesil bank) protects land which has evidently never been exposed to the destructive fury of the Atlantic swell and seas, which break with fury against the bank; for the land behind is composed of soft and easily disintegrated strata, which would speedily give way before such a power. Perhaps a gradual sinking of the land might produce the present appearances; for though the sea would have attacked the land when the relative levels were different, the form of the bay, and the projection of the Isle of Portland, would soon cause a beach to be formed, which would rise as the land sunk, so that finally no traces of a back cliff could be observed. Under this hypothesis Portland would not have formed an island, but merely the projecting point of a bay, which, with its exposure, would soon have accumulated the beach required. It may be remarked that this supposed gradual sinking of the land is in accordance with appearances more westward on the same coast, where the facts presented seem to require this explanation."[1]

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[1] Judging from the quaint map that accompanies this description, the Chesil bank must have been much the same in Drayton's time as now. However, all the nymphs that we saw were more or less clothed. The general appearance of the coast in question is shown in Plate XV., which is from a sketch made by Mr. Bristow twenty years ago; being a *view of the Chesil Bank and the "Fleet" or "Backwater," looking westward from near Fleet House.*

[2] Proc. Inst. Civ. Eng., vol. xii., p. 520 (1853).

Sir C. Lyell is the author of another theory. He says; "The formation of this bar may probably be ascribed, like that of Hurst Castle, to a meeting of tides, or to a great eddy between the peninsula and the land. . . . . We may expect the slightest impediment in the course of that tidal wave, which is sweeping away annually large tracts of our coast, to give rise to banks of sand and shingle many miles in length, if the transported materials be intercepted in their passage,"[2] In later editions this is repeated, with the addition "or to a submarine shoal or reef between the peninsula and the land," in which form it is supported by Mr. Coode, according to whom "the isolation of the bank is due to the existence of a level, or nearly level, bench of clay, upon which the shingle is thrown and rests, as upon a shelf."[3] In Sir C. Lyell's last work the theory is thus stated: "That part of the bar which attaches Portland to the mainland rests on Kimmeridge Clay, which is sometimes exposed to view during storms. The clay may have formed a shoal, and the set of the tides in the narrow channel may have arrested the course of the pebbles, which are always coming from the west."[4]

Colonel G. Greenwood, however, accounts for the occurrence of the Chesil bank on the supposition that, in consequence of a rise of the land, the sea would have a shallower shore, against which it could throw up the pebbles. His words are as follows: "Raised beaches exist along our south coast, and I think that it is the shallows caused by the rising of the land that has [have] allowed the accumulation of double beaches between Giens [East of Toulon] and the land, as well as between Portland and the land (Chesil beach and Smallmouth sands). . . . . Nature has no sooner divided the island from the continent than, by hoisting up the land, she sets the same workman, the sea, whom she first employed to sever them [it] from the land to join them [it] to the land again."[5]

These three theories may be described as the sinking theory; the standing still theory (by implication, as its advocates say nothing of rise or fall), and the rising theory; each of those conditions of the shore having been invoked in turn as best explaining the origin of the bank. Our own theory will, we believe, suit all conditions.

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[1] Geological Manual, Ed. 3, 8vo. Lond., 1833, p. 80. The theory is repeated in the author's later work, the Geological Observer, 8vo. Lond. (1851), p. 65, and Ed. 2 (1853), p. 56.

[2] Principles of Geology, vol. i. p. 281 (1830), 1st edition.

[3] Proc. Inst. Civ. Eng., vol. xii. p. 542 (1853).

[4] Principles of Geology, Ed. 10, vol. i. p. 534 (1867).

[5] Rain and Rivers, Ed. 2, 8vo. Lond. (1866), pp. 119, 132.

There is one point on which all must agree; it is that the bank could not have been formed without the huge natural groyne, or breakwater, of the Isle of Portland, which bounds it on the east, and stops the shingle in its easterly course; but beyond this we venture to differ from the explanations that have been given to account for the presence of the shingle in so anomalous a position.

The above theories rest on the supposition that the form of the neighbouring land, at the time of the formation of the bank, was much the same as now; and although the theory of Sir H. De la Beche would seem to allow that the beach might have been formed against land, and separated merely by the sinking of the land (in this case the shingle ought surely to have been driven back as the land sunk), yet the other theories imply that the bank was originally formed as a detached mass, separated from the land as now by a narrow channel of water, unlike other long tracts of shingle, which are formed against the land, and which, travel as they may, touch the land.[1] On the other hand, the theory that we suggest needs no such supposition, but starts with the reasonable assumption that the Chesil Bank may have been formed at first in the same way as the ordinary shingle-beaches of our coast, and that what was once an ordinary beach, banked up against the land, has been since separated, as a bank or bar, by the denudation of the land behind it, such denudation having taken place in a way that would hinder the backward motion of the shingle, and would leave a narrow channel (the present Fleet) between the bank and the land.

In order to make our theory more easily understood, it will be well to give a short description of the Chesil Bank. In doing this, we shall avail ourselves of Mr. Coode's account, which has made needless any measurements on our part; at the same time we ought to state that both of us can speak from personal knowledge of the coast and of the bank, the first named of us having done the Geological Survey mapping of that district, while the other spent great part of a summer holiday in an examination of the Dorsetshire coast.

The Chesil Bank (including under that name the whole of the continuous strip of shingle from Burton Bradstock to Portland) is the largest accumulation of shingle in this country, and more than fifteen miles long. On the N.W., for five or six miles, it touches the shore, but on the S.E., from Abbotsbury, it is divided from the main land by a shallow estuary about eight miles long, of variable breadth, but nowhere more than two-thirds and often less than a quarter of a mile wide, which is known as "the Fleet" or "Backwater" (Plate XV.); and for the remaining two miles, nearest to Portland, it has the sea on either side. It is with the last ten miles that we are now chiefly concerned, and to this part the following paragraph refers.

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[1] We are aware that at the mouths of many rivers bars of shingle stretch a long way across from one side, sometimes indeed to such an extent as to turn the rivers along the shore (between the land and the shingle), in the direction of the prevailing set of the currents, for some distance. But these are not really analogous to the Chesil Bank, where the shingle-beach is far longer, and where there is no river emptying into the sea, but only a succession of very small streams. There are also cases of shingle-banks completely damming up streams, and with a marsh or expanse of fresh-water on the land side, as at Slapton Sands, South Devon, and Cuckmere, in Sussex.

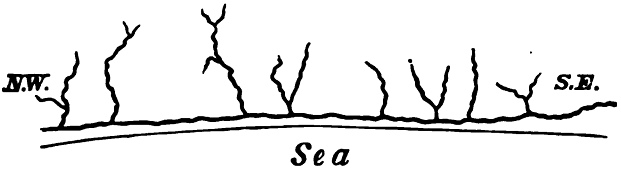
The average width at the base is 170 yards near Abbotsbury, and 200 yards at Portland. The height increases from N.W. to S.E, but the inclination of the crest is not uniform. At Abbotsbury, the crest is over 22 feet, and at Chesil over 42 feet high. Borings made down to high-water level, and sometimes lower, passed through nothing but beach (except at one place, where clay was met with deep down): ten or fifteen feet from the surface, the shingle was generally mixed with a little sand, and the quantity of the latter increased with the depth until the whole was found to be very compact.—(Coode.)

The largest pebbles are at the eastern end, and gradually decrease in size westward, until near Burton the beach consists of sand and very fine shingle. The accompanying map will make the above description clearer. (See Plate XIV.)

Westward from the end of the Bank the coast gradually gets higher, and soon there are high cliffs of Liassic, Jurassic, and Cretaceous beds. These cliffs are cut through at Burton and Charmouth by valleys with small streams, such as the Char and the Bredy, which, of course, flow seaward, that is in a south-westerly direction.

These streams (excepting the Bredy) do not breach the shingle of the bays where they flow into the sea, but turn eastward (the direction of the general set of the current) for a short distance, between the beach and the land, and then filter through the shingle. There is an interval of some miles between each of these successive streams, in which the cliffs are not breached by valleys, or only by such as are cut off at some height above the sea. On the other hand, along the low shelving shore eastward of Abbotsbury, the least approach to a cliff is a great rarity, and a cliff ten feet high is a marked object: here, therefore, the streams are much closer together, each hollow in the ground sending in its share of water to the still channel of "the Fleet."

Let us think now what would happen if in former times this latter part had been in the normal state of a beach skirting a low coast. The streamlets flowing down the small valleys would act just as those on the coast to the westward do; that is to say, they would turn eastward for some distance before filtering through the shingle, and most likely they would run the further between the beach and the mainland, by reason of the former being so much broader, higher, and more compact than it is on the coast. Now, as the streams are near together, instead of being separated by miles of unbreached cliff, it is quite possible (and we think most likely) that some stream might continue its easterly course between the shingle and the shore, until it reached the next stream. This might take place with several streams, where two were near together, and the increased force of two united would give the resultant stream greater power to continue its eastward course and to join on to the next. The consequence of the continuance of this process would be, that all the streams would at last join to form one long channel between the beach and the mainland, as in the subjoined Woodcut, which is on a larger scale than the Map (Plate XIV.), with the streams continued to the beach.



Plan of streams flowing to a shore where there is a current chiefly in one direction.

It seems well within the limits of possibility that this body of water would have power enough to keep its channel free, and to prevent the firm compact shingle from being driven back against the mainland. In this case the land would be protected from the cliff-forming action of the sea, but on the other hand would be subject to the scooping action of land-waters, which would cut it back in gentle slopes, and irregularly widen the channel, according to the nature and hardness of the different beds acted on.

Of course, on any theory, the Chesil Bank could not have been formed but for the existence of the natural breakwater of Portland; and, according to the theory now brought forward, either the narrow neck of land which must once have connected Portland with the mainland, has been breached by some means or other, inwards towards Weymouth Bay (instead of the beach being breached outwards to the sea); or, on the other hand, if at first the beach was broken through, and the stream flowed out to the sea in a southerly direction, that breach must have been slight enough to have been filled by the heaping up of shingle, when the land in its rear was worn away and Portland was separated from the mainland. As the connecting isthmus must have consisted of Kimmeridge Clay, its destruction would be no hard matter to the sea on one side (N.), and the stream on the other; and as large breaches in the Chesil Bank are known to have been refilled in a very short time, there is, perhaps, no great difficulty in accounting for the phenomena on either supposition.

The destruction of the land between Portland and the mainland on the north, has been made easier by the beds having been thrown into a sort of arch, with a sharp northerly and a gentle southerly dip; the arch being of course the form that helps denudation, both by fissuring the beds, and by giving them a tendency to fall outwards. In this particular case, moreover, the lower beds that have been brought to a higher level by the said arch, so as to be within reach of denuding actions, are of a softer and more destructible kind than those that overlie them.

There are three facts that seem to confirm the theory that the channel in the rear of the Chesil Bank has been formed since the heaping up of the shingle:—they are (1) that the isolated part of the bank is also the largest and strongest, the best able both to withstand the sea, and to stop the streams from flowing directly into the sea: (2) that the very irregular shape and cliffless character of the shore of "the Fleet" are not such as one would expect to be caused by the action of the sea along such a coast, whilst they are just what should be produced by the action of streams: and (3) that *the Channel ends where the streams end.* Westward of Abbotsbury, where there are no streams, the beach is not separated from the land; eastward of Abbotsbury, where there are streams, the beach is separated from the land.

Whether there may have been a slight rising or sinking of the land during the formation of the beach, would we think make little difference, on the theory which we have brought forward. Whilst we are far from asserting dogmatically that the Chesil Bank must have been formed in the way described, yet we think that our theory, or explanation, involves less supposition, and tallies more with observed facts, than any other does, and that, therefore, it should be accepted until replaced by a better, or disproved.

Lastly, we wish to draw attention to the confirmation given to the theory of *Subaërial Denudation* by our explanation of the origin of the Chesil Bank. It was not until we were convinced of the truth of the former that we saw our way to the latter; but when we began to see how great has been the share of rain and rivers in wearing away the land, and in cutting out hills and valleys, then we were enabled, by the new light thus gained, to explain the origin of a very uncommon phenomenon, which before we could not understand or account for. What had previously been a mystery, and looked like a freak of nature, became clearly intelligible, and was seen to be the natural result of ordinary causes and existing agencies.

Postcript.—In the discussion of this paper, Mr. J. Evans, F.R.S., "suggested that tidal action may have assisted materially in the formation and widening of the Fleet." This we are far from denying, although we omitted to notice in our paper the assistance that may have been given by that action when it was enabled to come into play.

II.—On a Raised Beach at Portland Bill, Dorset.

By W. Whitaker, B.A. (Lond.), F.G.S., of the Geological Survey of England.

[PLATE XIV.]

[A paper read before the Geological Society of London, May, 26, 1869.]

In 1850, Mr. H. W. Bristow recorded, on sheet 17 of the Geological Survey Map, the existence of "conglomerate" and "recent stone" at Portland Bill.—(See Plate XIV. herewith.)

In 1852, Mr. C. H. Weston,[1] noticed the occurrence of a "marine shingle-bed" on the top of the cliff, in the following words: "This remarkable bed consists of beach-pebbles (with a few chalk-flints), rounded by continued sea action. The quarrymen said it extended about a quarter of a mile north of the Bill."

In 1860 this shingle was again noticed in Mr. R. Damon's "Handbook of the Geology of Weymouth and the Island of Portland,"[2] and the occurrence of "comminuted shells" recorded.

Mr. Bristow has suggested to me that the shingle-bed may have been formed by the sea dashing up pebbles from the shore below, as he has known it to do in stormy weather; but I doubt whether that action is enough to cause so large a deposit. At all events it will not do so altogether, as the shingle is in part protected from such action by a thick covering of subaërial origin. Mr. Bristow tells me that, as far as he remembers, there was no good section of the deposit at the time of his visit, which must have been before 1850.

The southern side of "Cave Hole" is the most northerly point of this beach, which is there thirty or forty feet above the sea, and about three feet thick, being capped by a good thickness of angular "head" (the waste of Purbeck and Portland beds), and consisting of pebbles of limestone, flint, and chert. Just southward is a projecting cave-worn ledge, with a rounded water-worn surface of Portland Stone bared of the old beach. The next projection shows a little of the same, but with pebbles and shells conglomerated together into a hard mass adherent to the surface of the stone, the shells being chiefly *Littorina littorea*, but *Littorina littoralis* and *Patella vulgata* also occurring.

Further southward there is less of the "head," indeed hardly any, but there are remains of very small shallow pits, most likely dug for sand, as a small hole close by passed through two or three feet of clayey soil and more than three feet of coarse sand with shells, which, as far as one can judge from position, overlies the shingle.

The old beach ends, after a course of less than 250 yards, before reaching the slight headland, where however there are traces of it in the soil.

Continuing my southerly walk, just before getting to the Beacon at the Bill, I found shells (of the same species as those mentioned above, and also *Purpura lapillus*) jammed in with limestone-rubble at the top of the low cliff (as noticed by Mr. Damon).

At the Bill there is a little shingle, which increases after turning westward, when the cliff rises a little. At one place a pit six feet deep shows that this shingle is sandy and bedded, whilst near by it is conglomerated into a hard mass at the top of the cliff, and further inland another pit has been dug to a depth of eight feet. Close by, at the cliff a little higher up, the shingle is covered by yellowish-brown loam (calcareous ?) with bits of stone and with land and freshwater shells (*Bithinia*, *Pupa*). A little further the latter thickens and the former thins, but both end off at the projecting spur of rock.

[1] Quart. Journ. Geol. Soc., vol. viii., pp. 117, 8.

[2] 12mo. Lond., p. 141. Reprinted in 1864.

I believe that it is only to the part noticed in the last paragraph that Mr. Weston's remarks refer.

Postcript.—In the discussion of this paper, Sir C. Lyell said that he had found in this raised beach more species of shells than those above mentioned; and Mr. Prestwich said that at one spot the number of young shells was remarkably great as compared with that of older shells.

III.—ON THE OCCURRENCE OF *MACHAIRODUS* IN THE FOREST-BED OF NORFOLK.

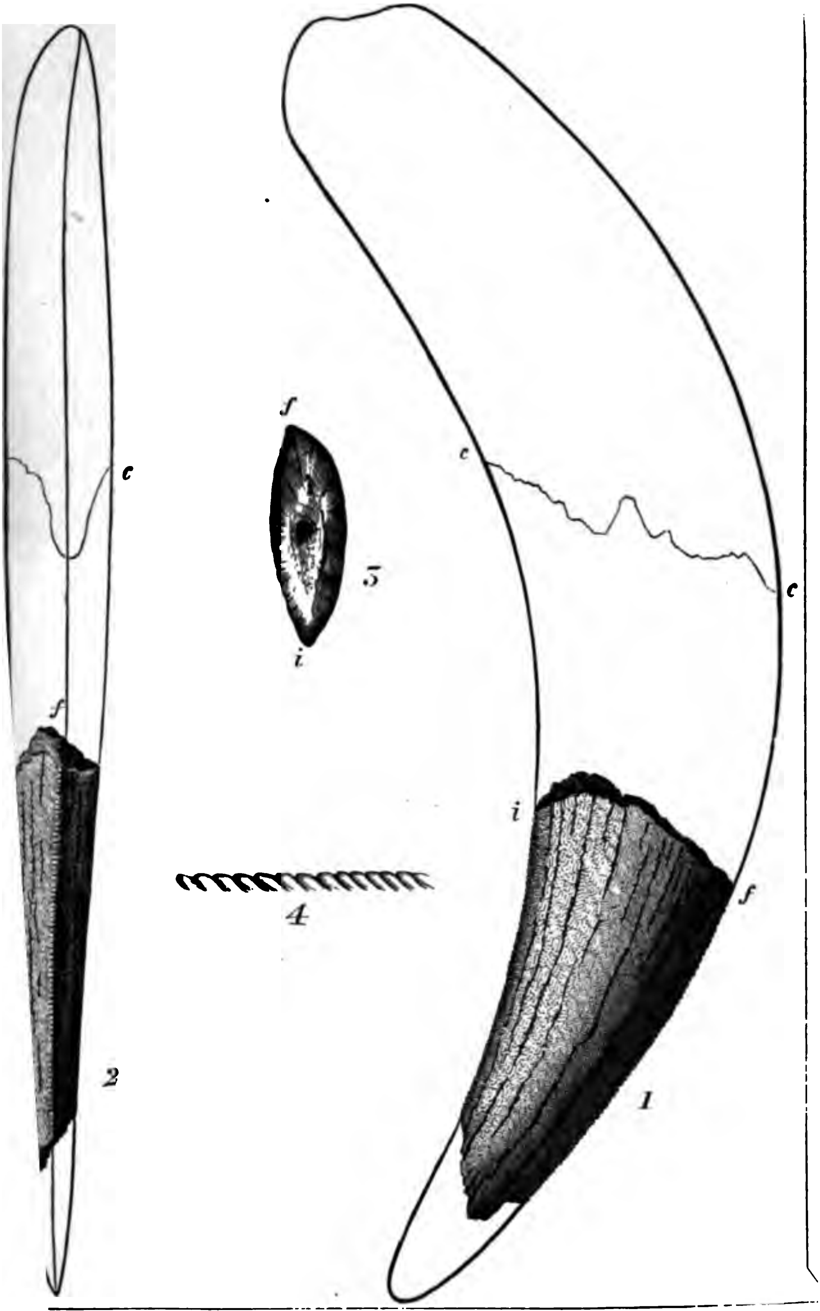
By E. RAY LANKESTER, B.A. Oxon.

[PLATE XVI.]

A SPECIAL interest has always attached itself in this country to the remains of that rare and bizarre carnivor, the Sabre-toothed tiger. For as yet it has only been indicated to us on this side of the Channel by the most fragmentary and unique specimens—the two teeth, incisor and canine, obtained by the Rev. Mr. MacEnery, from Kent's Hole, Torquay, the authenticity of which have even been doubted. Whilst, however, palæontologists have pretty generally come to the conclusion that these two isolated teeth are really the remains of a Devon Sabre-tooth, no further specimens have, I believe, been recorded from other caverns in this country.

The forest-bed of Norfolk, which furnishes remains of *Rhinoceros Etruscus* in some abundance, and of *Ursus Arvernensis*—and other forms associated in central France with species of *Machairodus*—has hitherto not given up any remains of that carnivor to the energetic collectors of Norfolk. In July, by the kindness of the Rev. John Gunn, I was enabled to see some of the matters of geological interest in Norfolk, and in looking through the very beautiful collection of mammalian remains from the Forest-bed in the possession of Mr. Jarvis, of Cromer, I observed the portion of a tooth figured here. Suspecting its nature, I begged the loan of it from its owner, who very courteously complied with my request. I have since carefully compared it with the casts and specimens of the canines of *Machairodus* in the British Museum, and determined it as a fragment of the right upper canine of a species of that genus. The only doubt which one could possibly have about such a specimen as this, with its characteristic serrations and outline (see Plate XVI.), was that it might belong to a large *Megalosaurian* whose remains had been brought down from more northern Jurassic beds, and cast on the Norfolk shore.

Two eminent Palæontologists to whom I shewed the fragment, suggested this account of its origin to me, whilst two others agreed in the view that it belonged to *Machairodus*. The known teeth of *Megalosaurus* are, however, smaller, and of a much more sharply curved outline, than is indicated by this specimen,



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S. Austin, im

TOOTH OF *MACHAIRODUS*,

Found in the Norfolk Forest-bed at Cromer.

and have, as appeared to me at first, a much less flattened form, presenting in section a full round outline on that side which forms the outer edge of the tooth's curvature. A comparison of specimens of *Megalosaurus* teeth with this Norfolk fragment, leaves no doubt as to their complete distinctness. On the other hand, the fragment agrees in detail, as well as in general appearance, with the right upper canine of *Machairodus.* The tapering of the tooth corresponds closely with that of a large-sized *Machairodus* canine, as shewn in the figure, one side of the tooth being a little more convex than the other. The serrated edges do not run vertically, so that the plane passing through them would divide the tooth into two unequal parts (see section Fig. 3); but, as is observable in *Machairodus,* the opposite serrated edges are not parallel to one another, but are curved—one slightly inwards, the other outwards. The enamel on both surfaces is longitudinally split and cracked, exactly in the same manner as it is on MacEnery's specimen from Kent's Hole. Therefore, small though this fragment is, it carries, sufficiently clearly marked on it, the evidence of the ownership of *Machairodus.*

The specimen is too incomplete to make any discussion of specific characters useful. As to its geological age, there is every probability that it came out of the Forest-bed, whether contemporaneous, in the period represented by that accumulation, with the recognized Forest-bed Fauna, or not. The specimen is of a black colour externally, of a deep brown on the fractured surfaces, and was picked up on the shore between high- and low-water, amongst the débris of the Forest-bed.

Whilst having the good fortune to add this interesting carnivor to the list of Forest-bed mammalia, I cannot let the opportunity pass of mentioning—what, indeed, has been recognized by those working at this deposit at home, but *not* by all writers—that *Mastodon* has not been found in the Forest-bed; and, that even were fragments of that genus to occur, we might have to regard them as derived from accumulations of an earlier period, just as it is possible, though not probable, that this *fragmentary Machairodus* canine may have been derived.

EXPLANATION OF PLATE XVI.

Fig. 1. Side-view of right upper canine of *Machairodus.*
[The *shaded parts* of Figs. 1 and 2 represent the Cromer Forest-bed specimen; the outlined entire canine is copied from the cast of a French specimen of *Machairodus cultridens,* Cuv., with the curvature of which the Norfolk fragment closely agrees. The outline of *M. latidens,* Owen, from Kent's Hole, tapers more rapidly than the Norfolk specimen, indicating a much shorter canine.—EDIT.]

Fig. 2. Front-view of right upper canine of *Machairodus,* showing the curvature of the serrated edge of the tooth.

Fig. 3. End-view of Mr. Jarvis's specimen, showing the serrated edges which divide the tooth into two unequal parts (*f* anterior, *i* posterior edge of tooth).

Fig. 4. A portion of the serrated margin of the tooth enlarged.

c. c. The part above this line is enclosed in the jaw, the other letters show the corresponding parts in Figs. 1 and 2.

IV.—ON THE DENUDATION OF WESTERN BRITTANY.

By G. A. LEBOUR, F.R.G.S., of the Geological Survey of England and Wales.

1. *Geology.*—STATED roughly, the geology of the Department of Finistère may be said to consist of two masses of granite, one to the north and one to the south, enclosing between them nearly the whole of the sedimentary rocks of the district. These consist of Cambrian slates and gneiss, Lower, Middle, and Upper Silurian slates and grits, and very small and unimportant patches of Upper Carboniferous shales. The entire mass of these deposits has an east and west direction, and occupies the central part of the Department.

All the country to the north of Brest, and extending from Normandy to the Isle of Ouessant, forms part of the northern granitic mass. Between this and the tongue of land to the south of Douarnenez, including the very indented peninsula of Crozon, we have the Cambrian and Silurian rocks powerfully undulating and forming the two loftiest chains of hills in the district—the Montagnes d'Arrhée and the Montagnes Noires—which run across the country close to and parallel to each other in an east and west direction. Immediately to the south of this wide band of Palæozoic formations, comes the southern mass of granite. Like the first, this has scattered here and there, over its whole extent, numerous isolated enclosed masses of metamorphic schists, which have, by Dufrénoy and others, been referred to the Cambrian age.

The coal shales mentioned above, as occurring in this district, are to be found in thin elongated patches at Quimper and at Cléden, on the west coast; their extent is utterly insignificant.

About two miles south of Quimper, near the hamlet of Toulven, is to be seen a small series of horizontal beds of Tertiary age (the only instance of the occurrence of such deposits in the Department) of which more will be said presently.

2. *Coastline.*—The coastline of Western Brittany is very irregular. The two great bounding masses of granite forming comparatively even and sweeping lines, interrupted only by the long, narrow, and winding creeks which are to be found at the mouths of all the rivers. These creeks are, however, quite minor features on these coasts, and are many of them hewn out of the micaceous schists which are interspersed among the granites. Where an estuary occurs in the granite itself, it is usually wider, and is bounded by flat sandy shores.

The cliffs along these coasts are low, with rounded and well-weathered tops. They are higher when composed of the metamorphic schists, which are much more compact and harder to disintegrate than the granites of these parts, and naturally form bolder and more striking cliffs.

The Cambrian and Silurian beds, on the other hand, which are enclosed between the two above-mentioned bands of granite, are, as a rule, characterized by high, steep cliffs, the faces of which are frequently much eroded into caverns, oftentimes of very considerable magnitude. The general line of this part of the coast is very inated, and forms an endless number of small bays, promontories, d headlands; as may be seen by glancing at the Rade de Brest in y map.

Along the southern granitic coast, the sea is very shallow for ne miles, and the numerous small islands with which it is studded ve exactly the same geological features as the mainland; thus owing that the southern granitic plateau has a much greater exnsion than the boundary of the coast alone would indicate. The s de Glénan are a case in point.

3. *General Surface Characteristics.*—The two great watersheds of country are formed by the two central chains of hills, the space tween them or "swire,"[1] which is very narrow and not much low the average height of the two flanking ranges, being for the st part covered with wet bog-land.

The Montagnes d'Arrhée supply the streams running to the north d north-west, and the Montagnes Noires those flowing to the south. Descending from these hills on either side, and proceeding to the ith or north, we find ourselves all the way to the sea in what pears at first sight to be an exceedingly hilly and disturbed intry. The streams are innumerable, and flow at the bottom of ep narrow rocky ravines, which intersect the country in every ection. Their course is most tortuous, and continues, with scarcely y noticeable difference of width or depth, alike through the hard urian grits and their enclosed traps, the vertical or contorted leafy tamorphic schists, and the variously-grained, easily decomposed inites. What slight change there may be, however, is most disnible among the latter rocks, where the valleys are sometimes newhat wider and less winding than in the former. The jagged pearance, moreover, of the rocky sides of these valleys tends to rease the mountainous and rugged aspect of the scenery. This, wever, is only the result of a superficial view of the physical tures of this district, and is by no means in accordance with the e facts of the case. These errors are perpetuated by the use sections across the country drawn on exceedingly exaggerated rtical scales; quite a universal practice abroad.

By drawing horizontal sections on a true scale, cutting the whole adth of the peninsula, the height and distances being taken from large government maps of these parts, and by carefully going er the ground along each line of section, added to a long acquaintce with the country generally, I have been enabled to arrive at conclusions, the statement of which is the object of the present per.

Following on paper one of these lines of section (a north and ith one) from the base of the Montagnes Noires to the southern -shore[2] we are immediately struck by the *absence* of marked

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I have ventured to use the old north country word "swire" to express the slack ween two hills. I think it might be a useful one to adopt in the description of sical features.

The result would be exactly similar were we to follow the northern half of the ion from the hills to the north coast.

features. Even when drawn to a large scale the surface line is a most even one, sloping insensibly towards the sea. The numerous valleys, which give the country its wild appearance, are seen on the section but as a number of little insignificant nicks, breaking for an instant only the continuity of the surface line, and even rendering the evenness of the latter more obvious by their very unimportance. The very slight and gentle undulations to which this surface line is subject are coincident with the changes in the geological conformation of the district across which it runs, and are sufficiently accounted for by the relative hardness and facility of disintegration possessed by the rocks which characterize them.

Looking, then, at the country from this new point of view, we have a long central line of hills standing boldly between two plains, each of which slopes gently to the sea. These plains I look upon as the work of the last great marine submergence of Western Brittany,—as, in fact, being *plains of marine denudation*. The formation of the valleys by which these plains are as it were gouged in every direction, I regard as being due to quite different, and, in part at least, to much more recent causes.

4.—*Date of submergence.*—It has been repeatedly stated, and it is indeed held by many as an established fact, that the whole of Brittany has been dry land since very early geological times.

That this may not be true for the median range of hills of Western Brittany there is no evidence whatever to show; and indeed it is most probable that the old rocks of which they are composed have not been exposed to the action of the sea since very ancient times. They no doubt stood out as a tongue of dry land during the subsidence, and planing down of what I will now term the northern and southern plateaux of Finistère.

Whether this submergence took place several times or only once, and when, I am not aware of any means of determining at present. But I think that there is sufficient evidence to induce us to believe that the last great submergence was a comparatively recent event.

The northern plateau is remarkably deficient in any deposits of later date than the Devonian. At one particular spot on the southern plateau, however, as has been mentioned above, there is an isolated patch of sands and clays which has been referred to the Tertiary age. These beds are lying perfectly flat upon the upturned edges of a mass of micaceous schists; they stand above the general level of the country, and if produced at their present horizon they would spread over a great portion of the southern plain. They are unfortunately quite devoid of any organic remains by which their exact age might be satisfactorily settled. In general appearance, however, in lithological character, as well as in relative position, they agree very closely with some deposits of undoubted Miocene age in the neighbourhoods of Dinan and Rennes. These last-named beds are all marine, and in the total absence of any palæontological evidence to the contrary, it may, I think, fairly be admitted that the patch in question at Toulven, near Quimper is also of marine origin. Indeed the appearance of the beds is such as seems directly opposed to the notion of their freshwater origin.

Now, taking this isolated patch to be the remnant of a large ctent of similar beds deposited over the district during its subsi- ›nce beneath the Upper (?) Miocene sea; we have, I think, enough prove that marine action has been at work over a considerable ırt of Western or Lower Brittany, at least during the middle of ıe Tertiary epoch—a date of submergence much more recent than ıs usually been supposed probable for this country.

That the loose sandy deposits formed at the bottom of the Miocene a should have all but entirely disappeared from the surface is only hat one would expect to be the case, considering the vast time hich has elapsed since their deposition, and probably also since ıeir emergence and consequent exposure to the denuding power of ıe various subaërial agents. Indeed this one little patch, which is ›w the only memento left us of that ancient condition of things, as only saved by its position, and probably consists of merely some f the higher members of the series.

Taking all these things into consideration—the two gently-sloping lains of marine denudation, separated by a high pre-existing water- ırting ridge, from whose sides no doubt streams ran into the iocene sea during its slow advance and recess, as they do now into ıe Atlantic and the Bay of Biscay,—there seems but a very small fort of the imagination required to suppose that the rivers which e now winding their way across the face of the country are, in ıeir upper part at least, identical with those which were running in similar manner during and previous to this epoch of submergence. hat they have themselves worn and excavated the narrow gorge- ke valleys at the bottom of which we now find them, I think › one who has visited this part of Brittany, will doubt for a oment. Many of these river-valleys I have examined minutely, ıd in no case have I found that they coincided with any marked ıes of weakness such as faults, fissures, &c.

One of the principal difficulties connected with these deep and ırrow river-valleys, is the extraordinary constancy of their width ıd depth, which, as I observed before, continues good, quite gardless of the various hardness and capacity for erosion of the fferent rocks through which they pass.

The assumption that these valleys are the same as those which ere scooped out during the retreat of the middle Tertiary sea, ems however, to afford a sufficient explanation of this curious ct; inasmuch as the hardest rocks (the Silurian grits), being those the centre of the country (that is—those, a part of which were ways dry land, and the rest of which were the first left uncovered y the retiring sea), and the hardness of the different rocks forming ıe mineral characters of the country *decreasing* regularly from the ntral chain to the sea, both north and south,—it is plain that the me which has elapsed since they respectively emerged from the sea ıd became a prey to the action of running water, would have a mpensating influence over the erosive power of the latter, the ftest rocks having been last under water. This explanation quires the existence of certain conditions; such as, that the scale of hardness of the rocks in question should be exactly counterbalanced by the time taken by the retreat of the sea, the existence of which it would be very difficult to prove. I merely bring it forward for what it may be worth, as an explanation which, if it may not be the true one in the present case, yet may, I doubt not, be applicable to others.

5. *Summary.*—The conclusions I have endeavoured to shadow forth in this paper may be briefly summarized as follows:

1. That with the exception of a central double range of *mountains of elevation*, Western Brittany consists of two great northern and southern *plains of marine denudation.*

2. That the last time these plains were exposed to the action of the sea, was in Upper (?) Miocene times.

3. That the rivers of Finistère are identical with those which flowed from the central dry-land into the Miocene sea.

4. That the valleys at the bottoms of which these rivers run are the result of their erosive action, aided by other subaërial agents.

5. That the uniformity of depth and breadth at present displayed by these valleys is due to the degree of hardness of the rocks in this district, being in an order of succession directly inverse as the time during which they were submerged beneath the middle Tertiary sea, and exactly proportionate to that during which they have been exposed to present subaërial influences.[1]

V.—NOTES ON THE NORTHAMPTON OOLITES.

By SAMUEL SHARP, F.S.A., F.G.S., etc.

ATTENTION having been drawn of late to the "Northampton Sand" by the able papers of Mr. George Maw and Mr. Judd, and by the discussions which arose upon them, and to the Oolitic beds of Northamptonshire generally, by the too concentrated article (so rich in information) by Professor Morris, in the GEOLOGICAL MAGAZINE for March, and by a letter from the Rev. P. B. Brodie elicited thereby in the May number, I venture to offer the following provisional statement as to the Oolitic strata in the neighbourhood of Northampton, and the order in which they occur, purposing at some future time to write more fully upon them, to enumerate the palæontological contents of each bed, and to endeavour to correlate the Northampton series with those occurring in the more northerly parts of the county and around Stamford.

The thickness of the beds respectively varies greatly. I have stated the maximum thickness of each in feet:

Great Oolite.	1. White Limestone	25	feet.
	2. Blue and Grey Clay	15	„
	3. White Sand	12	„
	4. A Series of very variable beds—more or less ferruginous	30	„
	[Place of the Stonesfield Slate, which is absent.]		
Inferior Oolite.	5. Coarse Shelly Calcareous Oolite, with numerous Fossils	4	„
	6. Sandy Slate with Fossils	3	„
	7. Ironstone Beds - from 1 foot to	25	„
	Upper Lias.		

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[1] Read at the British Association Meeting at Exeter, in Section C., on Saturday, the 21st August, 1869.

Upon the foregoing beds I will remark briefly :

1. The White Limestone is disposed in beds from a few inches to bout three feet in thickness, much fissured, and contains characterstic Great Oolite fossils. It is traversed by an earthy zone of from to 18 inches thickness, made up of thin laminæ, and containing lattened bivalves, which are well preserved. This limestone passes lown into—

2. Blue and Grey Clay. This clay is used in many places for rick-making. At Kingsthorpe, at the base of the limestone, is a one containing *Rhynchonella concinna* and *Modiola imbricata* in abunlance, and these are found also in the underlying clay to the depth f a few inches. In the same section a zone of *Ostrea Sowerbyii* occurs in the limestone; in some other localities these same forms occur in the clay beneath. This clay passes down by an easy transiion into—

3. White clayey sand, with occasional ferruginous stains. In ome places this sand has become so indurated as to be used as a uilding stone, and has proved very durable. Few fossils occur in his sand, but at its base there occurs a plant-bed, composed of hin alternating layers of sand and vegetable matter of a thickness of rom 6 to 12 inches, overlying a band containing root perforations unning down to a depth, in some instances, of two feet. Conformble to these sands is—

4. A series of very variable beds, composed sometimes of ferruginous sandstone, in thin layers which overlie calcareous beds conaining shelly zones and plants, false bedding being frequent. ometimes the whole section presents a series of beds of compact erruginous sandstone, with no fossils—an excellent building-stone; n one instance the entire section consists of white sand and sandtone. Near the bottom of the beds there occurs in some localities zone of coral, composed chiefly of *Thamnastrea*.

Immediately beneath these beds I have placed, as above, the tonesfield slates, not in accordance with any conclusion arrived at y myself, but upon information derived from certain geologists hose opinions are worthy of all respect, and whose aid, together ith that received from time to time from other geological friends, will take a future opportunity of more particularly acknowledging.

5. A coarse shelly Calcareous Oolite. I will here content myself ith saying that this bed is in texture much like some of the Stamord limestones, and, like them, it contains Inferior Oolite fossils—*ima grandis*, etc. Associated with this bed is—

6. An Arenaceous Slate-bed, worked anciently for roofing slates, nd which, because of its position with reference to beds above and elow it, I have for some years held to be equivalent to the Collyeston slates, and with the latter to belong to the Inferior Oolite eries. What little merit may be due for such identification, I think may claim. Immediately under, and conformable with, this slateed are the interesting—

7. Ironstone-beds. These are so variable in thickness that, though t Kingsthorpe they are represented by a bed one foot thick, at

Duston, within a distance of a mile and a half, they present a section of 25 feet. They here consist of a dark red brown rock, having a cellular texture (the walls of rich iron ore enclosing ochreous cores), and are disposed in some seven or eight beds, from three to five feet in thickness, divided by joints and fissures, and traversed by shelly and coral zones, and a plant-bed. Near the top is a zone crowded with *Astarte elegans*, associated with which occur patches of *Astarte minima*; this zone is persistent over a considerable area, and is useful in determining at other points the general sequence and position of certain beds. The fossils are generally characteristic Inferior Oolite forms ; but with them is found *Pholadomya ambigua* (?) and from near the bottom of the series have been obtained, from widely-separated localities, two well-defined examples of *Ammonites bifrons*. This leads me to conjecture that, in the lowest portion of the Ironstone-beds of the Northampton Sand, we have a passage-bed from the Upper Lias to the Inferior Oolite, representing, perhaps, the Cephalopoda-bed of the Cotswold Hills and the sands below. The Palæontological evidence, I think, proves conclusively that the Northamptonshire ironstone (all below the coarse shelly limestone No. 5, and the slate-bed No. 6, and including these beds, down to the Upper Lias Clay) is Inferior Oolite.

A study of these Northamptonshire beds reveals the interesting phenomena of repeated alternations, during their deposit, of marine and estuarine conditions. I think it probable that a careful examination of the several strata over a large area might determine the character and direction of each estuary. Indeed, from the relative localities of the thickening and thinning of the ironstone-beds, I have an impression that the estuary which they represent had a direction north-east to south-west.

DALLINGTON HALL, NORTHAMPTON,
AUG. 19, 1869.

NOTICES OF MEMOIRS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, EXETER. AUGUST, 19TH, 1869.

SECTION C.—GEOLOGY.

Address by PROFESSOR ROBERT HARKNESS, F.R.S.. F.G.S. (of Queen's College, Cork), President of Section C.

IT has of late become the custom to open the several Sections of the British Association with an introductory address. This custom had, I believe, its origin in this Section when the Association met at Aberdeen; and upon that occasion Sir Charles Lyell made the important discovery of the late M. Boucher de Perthes, of the occurrence of flint weapons with the bones of extinct mammalia in the gravels of the Valley of the Somme, the subject of his opening address. In some instances new matter of importance in connection with geology has furnished materials for the opening address; but more frequently subjects of local interest have supplied the matter for this purpose, and it is in connection with the latter that I shall occupy for a short time your attention.

In no portion of Great Britain have we a better development of the series of rocks which forms the link between the well-established Devonian formation and the succeeding well-recognised Carboniferous group than in this county. The rocks which form the link I refer to are known to geologists as the Pilton Beds, deriving their name from the locality in Devonshire where they are best developed. These rocks have been made the subject of investigation by Sir Roderick I. Murchison, Professor Sedgwick, Sir H. T. de la Beche, Mr. Weaver, Mr. Godwin-Austen, Professor Phillips, and others; and of late they have been carefully examined by Mr. Jukes, Mr. Salter, Mr. Townshend Hall, and Mr. Etheridge. My reason for referring to these rocks is to point out their relation to certain strata which are very well exhibited in the south-west of Ireland, and which occur in a horizon corresponding to the Pilton Shales. The Irish representatives of the Pilton Shales are marked by a mineral aspect very nearly allied to their equivalents in this country; and they contain organic remains of a type very closely approximating to those found in the Pilton rocks. Before alluding to the Pilton Beds, I will refer to their Irish representatives, and to the rocks upon which these repose. In doing so, I shall avail myself of the labours of the late Mr. Jukes, and the other officers of the Irish branch of the Geological Survey, who were for several years engaged upon these rocks.

And here permit me to pay a passing tribute to the memory of one who has so recently been removed from the scene of his labours. For more than eighteen years the late Mr. Jukes filled the office of Director of the Geological Survey of Ireland; and the numerous maps and memoirs which have emanated from this Survey while under his control speak alike of the labour and accuracy with which this work has been done. Every geologist personally acquainted with the late Mr. Jukes must know how ready he was on every occasion to impart all the knowledge he possessed to those who sought it; and that earnest love of his subject and kindness of heart which so distinguished him caused him to be beloved by all who had the pleasure of his acquaintance. On many occasions this Section of the British Association has had valued communications from him; and many who are now present will well remember the apt and vigorous manner of Mr. Jukes when he had anything to address to this Section.

The portion of Ireland nearest Devonshire where we have rocks which can be compared with those of this county, is the neighbourhood of the town of Wexford. Here are strata reposing upon Cambrian rocks, which have been assigned to the Old Red Sandstone by the officers of the Irish Survey, and which attain a thickness of about 00 feet. At the western extremity of the county of Wexford, at Hook Point, the Old Red Sandstones are from 600 to 700 feet thick. In the Comeragh Mountains, to the north-west, they have a thickness of not less than 1,700 feet; and south-west from the Comeraghs, near Dungarvon, they are upwards of 3,000 feet in thickness. In the west of the county Cork we have 5,000 to 6,000 feet of Old Red Sandstone exposed; and here the upper portion is denuded and the base is not seen. In the Glengariff and Killarney country from 8,000 to 10,000 feet of these strata are exhibited, and here also their base is not visible.

On the south side of the Dingle Promontory the Old Red Sandstones occur under different circumstances. They are here from 3,000 to 4,000 feet thick, and are seen resting *unconformably* on rocks which are of a reddish purple colour, and at least 10,000 feet in thickness. These reddish purple beds repose conformably on the representatives of the Ludlow series.

The strata of the south of Ireland, which represent the Old Red Sandstones, and which in the neighbourhood of Glengariff and Killarney attain a greater thickness than 10,000 feet, are extremely barren in organic remains. Several thousand feet of strata, consisting of purple, red, and green beds, which, from being well developed in the district of Glengariff, have received from the Irish Geological Survey the name of "Glengariff Grits," have never yet afforded a fossil. It is only in the upper portion of the series, which is comparatively thin, and composed of Yellow Sandstones, that organic remains occur; these consist of remains of plants, which, at Kiltorcan, in the county Kilkenny, are in a beautiful state of preservation. Fish remains are also found referable to the genera *Coccosteus* and *Gyrolepis;* likewise a very characteristic shell, *Anodon Jukesii*, and Crustacean remains in the form of a species of *Eurypterus*, etc.

In Ireland the strata which succeed conformably the Yellow Sandstones have been called by Sir R. Griffiths the Lower Limestone and Shales. In the south of Ireland these strata have a great thickness, and when they possess a slaty cleavage the term "Carboniferous Slate" has been applied to them. These strata, in the eastern portion of the county Wexford, where the old Red Sandstones are thin, have no distinct existence. In the western part of the same county, at Hook Point, where the old Red Sandstone deposits are thicker than in the eastern portion of Wexford, the Lower Limestone shales make their appearance as a distinct group, separating the Yellow Sandstones below from the Carboniferous Limestones above; and here their thickness is between 10 and 20 feet.

We have already seen how the Old Red Sandstones have increased in thickness in the neighbourhood of Dungarvon. The Carboniferous slates also attain a much greater development here than at Hook Point, for the officers of the Geological Survey give their thickness at 700 feet; and near Youghal, still further westward, they have a thickness of about 900 feet. On the western side of Cork Harbour we have examples of a still greater development of the Carboniferous slates, for here they are at least 1,500 feet thick. At the Old Head of Kinsale, 6,500 feet represent their thickness; and still further westward they attain to even a greater development

In the county of Cork, gritty bands make their appearance in the Carboniferous slates. In the eastern portion of the area, where the grits first occur, they are thin and very irregular. They become very thick in the western portion of the county; and in Coomhola glen they have their greatest development, being at least 3,000 feet in thickness. These gritty beds have been termed "Coomhola grits." They contain some peculiar fossils, and they have others in common with the Carboniferous slates. They are interstratified with slate bands; and, although most extensively developed near the base of the Carboniferous slates, they are merely local members of this series, emanating from conditions somewhat different from those whence the great mass of the Carboniferous slates originated.

Having described generally the arrangement of the rocks of the south of Ireland which represent the Pilton beds, and also the deposits which support them, we have now to refer to North Devon. On the north side of Baggy Point, and eastward thereof, there are hard purple sandstones, possessing many of the features of the sandstones of the South of Ireland, which immediately underlie the "yellow sandstones;" and upon these in North Devon are light-coloured beds, which represent the Irish Yellow Sandstones. In the neighbourhood of Marwood, reposing on the equivalent of the Yellow Sandstones, are greenish-grey grits, affording a group of fossils intimately allied to those contained in the Coomhola grits; and among these are plant-remains identical with such as occur near the base of the Carboniferous slates. These have been obtained by the Rev. Mr. Mules.

Their mineral nature and fossil remains place the Marwood sandstones and the Coomhola grits on the same horizon. The fossil plants which occur near the base of the Carboniferous slate and in the Marwood sandstones, are specifically identical with such as are found at the base of the Carboniferous formation in the north of England. Here *Filicites linearis* and *Sagenaria Veltheimiana* occur, and these are the forms which the base of the Carboniferous slates afford. The Pilton rocks succeed the Marwood sandstones, and these Pilton rocks, in their mineral nature, are intimately allied to the Carboniferous slates. The strata which make up the Pilton group consist of shales and slates, generally of a dark colour, with associated sandstones and gritty beds, and occasional thin bands of limestone full of corals. The fossils of the Pilton rocks are very closely connected with those of the Carboniferous slates. Forms, however, occur in the Pilton beds which have not yet been recognised in their Irish representatives. There are species of *Phacops, Strophalosia productoides,* etc., etc. But such fossils as are most abundant in the Pilton rocks are those which are most common in the Carboniferous slates.

There is an idea prevalent among many English geologists, that the Coomhola grits are a series of rocks distinct from and lying beneath the Carboniferous strata; and this idea has, I believe, given rise to erroneous impressions concerning this series. I have pointed out that this is not the conclusion of the officers of the Irish Geological Survey, and my own observations have led me to results similar to theirs.

I hope this meeting will afford more information concerning the Marwood beds and the Pilton rocks, and that we shall have further evidence which will enable geologists to say whether these strata shall be referred to the Devonian group or to the Carboniferous formation. A band of pale slates, with a few Bivalves, lies between the purple sandstones of Mort Bay and the greenish-grey grits of the Marwood series. It is desirable that further information should be afforded concerning these strata and their fossil contents.

It appears to me that the boundary between the Devonian or Old Red Sandstones and the Carboniferous formation is, in the British Isles, placed in different horizons. In Ireland, the Carboniferous slates and the interbedded Coomhola grits are referred to the latter, while in this country the equivalents of these are looked upon as appertaining to the Devonian formation.

Besides the Marwood sandstones and the Pilton rocks, there are other matters of great interest in connection with the geology of Devonshire. The Triassic strata of this county in the neighbourhood of Budleigh Salterton, have within them some peculiar pebble-beds, which have been described by Messrs. Salter and Vicary. These pebble-beds abound in fragments containing fossils similar to those which the Silurians of Normandy afford. Recently these Triassic strata have yielded to Mr. Whitaker important palæontological evidence in the form of reptilian remains, which Professor Huxley has referred to the genus *Hyperodapedon*. This evidence goes a long way towards supporting the conclusion that the Lossie-mouth sandstones near Elgin are of a much newer age than their stratigraphical arrangement would seem to indicate; and that they belong to the Trias rather than to the Old Red Sandstones, to which they have previously been referred by many geologists.

In Devonshire also we have a better development of the Miocene strata than is to be found elsewhere in the British Isles, and the locality where these strata occur is within a short distance of Exeter. I refer to Bovey Tracey and its Lignite beds. These latter have been made the subject of a very valuable communication to the Royal Society by Mr. Pengelly. The plant-remains which have been obtained therefrom have been described by the eminent Swiss Botanist, Dr. Oswald Heer; and, thanks to the generosity of that noble-hearted lady, Miss Burdett Coutts, who is alike desirous to promote science and to alleviate human suffering, the fossils obtained from these Bovey Tracey lignites are now well known to geologists.

The plant-remains which these strata contain are the relics of a vegetation which, during the Lower Miocene epoch, spread over a large portion of the continent of Europe, and extended into the Arctic regions of America; a vegetation which clothed not only Europe with lofty forest trees and a rich undergrowth of smaller plants, but which also covered Greenland and Spitzbergen (lands which are now the abode of ice and snow) with an equally rich vegetation.

This extensive diffusion of similar forms of plants during the older Miocene period speaks to us of a widely extended uniform climate, contrasting strongly with the climates which now prevail in the temperate and Arctic regions of the northern hemisphere.

There is another matter connected with the geology of Devonshire which has special interest. This is the caves of this county, and their contents. These have been made the subjects of many valuable communications to this section by Mr. Pengelly and the gentlemen who are associated with him in the Committee for the exploration of Kent's Hole. But as we now are in a locality so near the source whence so much of interest has come, I believe that this section will again have before it important matter referring to Kent's Hole, and other Devonshire caverns; and I cannot doubt that many members of the British Association will avail themselves of the opportunity of examining the spot whence so much valuable information has been derived bearing upon the early history of the human race.

Geology and Archæology are now shading into each other, and although the early history of man remained for a long time like distant land, dim and ill-defined,—of late, owing to the labour of Sir Charles Lyell, Sir John Lubbock, and others, we are acquiring a clearer conception of our early ancestors, of their mode of life, and the conditions under which they existed.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. EXETER, AUGUST, 19TH-24TH, 1869. LIST OF PAPERS COMMUNICATED TO THE GEOLOGICAL SECTION (SECTION C.)

PROF. R. HARKNESS, F.R.S., F.G.S., ETC., President.

R. A. C. Godwin-Austen—The Devonian Group Considered Geologically and Geographically.

P. M. Duncan, M.D.—Second Report of the Committee on British Fossil Corals.

J. Thomson—Report of the Committee on Sections and Photographs of Mountain Limestone Corals.

G. W. Ormerod—Sketch of the Granites of the Northerly and Easterly sides of Dartmoor.

W. Pengelly—Source of the Miocene Clays of Bovey Tracey.

T. Davidson—Notes on the Brachiopoda hitherto obtained from the "Pebble Bed" of Budleigh Salterton.

E. Hull—On the source of the Quartzose Conglomerates of the New Red Sandstone of Central England.

H. Woodward—Fresh Water Deposits of the Valley of the River Lea, in Essex. (See GEOL. MAG. p. 385.)

Fifth Report of the Committee on the Exploration of Kent's Cavern; with Notes on the Mammalian remains. By *W. Boyd Dawkins* and *W. A. Sanford.*

H. H. Howorth—On the Extinction of Mammoth.

W. Pengelly—On the alleged occurrence of *Hippopotamus major* and *Machairodus latidens* in Kent's Cavern.

W. Hellier Baily—Report of the Committee on the Fossils of Kiltorcan, Co. Kilkenny.

C. Moore—On a Specimen of *Teleosaurus* from the Upper Lias.

G. Maw—On the Trappean Conglomerates of Middletown Hill, Montgomeryshire.

W. Carruthers—On Reptilian eggs from Secondary Strata.

„ „ —On Slickensides.

J. Thomson—On Teeth and dermal structure associated with *Ctenacanthus*.

Pierre de Tchihatchef—Paleontologie de l'Asie Mineure.

H. Woodward—On the occurrence of *Stylonurus* in the Cornstones of Hereford. On the discovery of a large Myriapod of the genus *Euphoberia* in the Coal Measures of Kilmaurs, near Glasgow.

J. Randall—On the denudation of the Shropshire and Staffordshire Coal-field.—*Communicated by W. W. Smyth.*

C. le Neve Foster—On the occurrence of the mineral Scheelite at Val Toppa Gold Mine, near Domodossola, Piedmont.

J. E. Taylor—On certain phenomena in the Drift, near Norwich.

„ „ —The water-bearing strata around Norwich.

G. A. Lebour—Denudation of Western Brittany.—*Communicated by R. A. C. Godwin-Austen.* (See *ante*, pp. 442-446.)

„ „ —Notes on some granite of Lower Brittany.

H. A. Nicholson—On some new forms of Graptolites.—*Communicated by the President.*

C. Moore—Report of the Committee for the purpose of Investigating the Veins containing Organic Remains which occur in the Mountain Limestone of the Mendips, and elsewhere.

H. Brady.—Notes on Mr. Moore's Foraminifera from Mineral Veins.

C. W. Peach—Notice of the Discovery of Organic Remains in the rocks between the Nare Head and Porthalla Cove, Cornwall."

H. Bauerman—Report of the Committee on "Ice as an agent of Geologic change."

R. Brown—On the Elevation and Depression of the Coast of Greenland.

G. Maw—On Insect Remains and Shells from the Lower Bagshot Leaf-bed of Studland Bay, Dorsetshire.

J. Thomson—On new forms of *Pteroplax* and other Carboniferous Labyrinthodonts, and of Megalichthys; with notes on their Structure, by Dr. Young.

Dr. Hicks—On the Discovery of Fossil Plants in the Cambrian Rocks (Upper Longmynds) near St. David's.

Dr. Mann—On the Gold of Natal.

L. C. Miall—Experiments in illustration of the Contortion of Rocks.

J. Bryce—Report of the Committee on Earthquakes in Scotland.

W. S. Mitchell—Report of the Committee for the purpose of investigating the Leaf-beds of the Lower Bagshot series of the Hampshire Basin.

R. Etheridge—On the occurrence of a large deposit of Terra-Cotta Clay at Watcombe, Torquay.

Rev. J. D. La Touche.—An estimate of the quantity of sedimentary deposits in the river Onny.

J. L. Lobley.—On the distribution of the British Fossil Lamellibranchiata.

Rev. J. D. La Touche—On Spheroidal structure in Silurian Rocks.

N. Whitley—On the distribution of shattered chalk-flints and flakes in Devon and Cornwall.

Professor Tennant—Diamonds received from the Cape of Good Hope during the last year.

J. Jeffreys—On the action upon earthy minerals and compounds, of water in the form of heated steam, urged by wood fuel, &c.

J. W. Reid—On the Physical causes which have produced the unequal distribution of land and water between the Hemispheres.

C. Jecks—On the Crag Formation.

J. E. Lee—Notice of remarkable Glacial Striæ, lately exposed at Portmadoc.

REVIEWS.

I.—Voyage Geologique dans les Republiques de Guatemala et de Salvador, par M.M. A. Dollfus et E. de Montserrat. Paris, 1868.

MM. Dollfus and Montserrat were attached as Geologists to the Scientific Mission which accompanied the Mexican Expedition from France in 1864. The volume before us, printed at the Imperial Press in a magnificent quarto, contains their Report on the Geology, not of Mexico, but of the Central American Provinces of Guatemala and San Salvador, to which they directed their researches, finding the political state of Mexico at the time unfavourable to their object. The volume is illustrated with maps, sections, and engraved views. A large portion of it contains the narrative of several journeys through this part of Central America, undertaken by the authors, with chapters on the physical geography, climatology, and meteorology of the country. We shall, however, pass at once to those which describe its geological features, especially the volcanic formations and phenomena of which this portion of America presents some of the most interesting examples to be met with on the globe. This part of the work comprises not only the personal observations of the authors, but also extracts from the accounts of earlier observers.

The axis of this section of the American continent appears to consist of granite shouldering off a series of metamorphic and sedimentary rocks, Mica and Talcose schists, with patches of Jura limestone, chiefly occurring on the eastern slopes, *i.e.*, towards the Atlantic, which are much broader and less steep than those towards the Pacific. The watershed line dividing the two is formed, for the most part, of a rock, to which these Geologists give the name of trachytic porphyry, which appears to have been developed on a most extensive scale throughout a zone stretching in the direction N.W., S.E.; that is, coincident with the general trend of the continent. No Tertiary, or other marine strata of later date than the Jurassic, are met with, so that this part of the continent appears to have emerged from the ocean at an early Geological period—all its later formations being apparently the product of subaërial volcanic eruptions. That the great mass of trachytic porphyry which is described as composing the substratum of the entire country south of the dividing range, and the basis on which its vast volcanic mountains are piled up, is itself of volcanic origin, an outflow, or successive outflows, from some great eruptive fissure, admits of little doubt. But our authors seem to entertain much uncertainty as to the mode and period of its formation. Coming to the country direct from the School of Mines of Paris, they are naturally imbued with the doctrine of "Soulévement" so persistently taught there in relation to volcanic rocks in general, and consequently see in this great development of trachytic porphyry, a vast "Soulévement," or series of Soulévements, disconnected from the volcanic eruptions, which, however, they cannot but acknowledge, have thrown up enormous cones of cinders, pumice, and ash, in the very midst of these trachytic masses (p. 257). This rock is described as of various tints of brown, grey, and violet, composed of a paste sometimes compact, but generally rough-grained and porous, occasionally scorified, containing numerous small crystals of glassy felspar, and a few plates of mica and needle-like crystals of hornblende, a description tallying with the ordinary varieties of trachyte, as seen in the Mont Dore and Cantal. This rock is accompanied by equally vast accumulations of its appropriate pumiceous conglomerates. Basalt also appears at several points on a large scale, together with its special augitic conglomerates, beds of scoriæ, lapilli, etc., and *these are often interstratified* with the pumice-tuffs belonging to the feldspathic series.

The most prominent and most interesting feature of the geology of this country consists undoubtedly in the train of prodigious volcanic cones which stud the western slopes and shore, many extinct—not a few recently, or still, in active eruption. The view of a portion of this range, as seen from the sea due south of Guatemala, given in the illustrations to this volume, is very striking; though allowance must, we presume, be made for some slight exaggeration in this as well as some other views of the angle of slope of the outlines of these lofty and very regular sugar-loaf-shaped cones. Some of these our authors ascended, generally finding a crater, often of large dimensions, at the summit; some being perfectly at rest, others—especially those whose recent eruptions are recorded—discharging volumes of acid and sulphurous vapour from crevices (fumaroles). We have not space to dwell long on these interesting formations, but will shortly recapitulate the chief examples described by our authors. Beginning at the Bay of Fonseca, in lat. 13°, we have first the shattered cone of Coseguina, which, during the tremendous eruption of 1835, lost probably a full half of its height, the upper portion being blown into the air by a series of terrific explosions which lasted from the 20th January to the end of the following month, and were heard at distances of 1500 and 2000 miles. Showers of ashes were distributed over the surface of the continent and both adjoining oceans, through a space of the same prodigious diameter, reaching as far as Jamaica to the north, and Bogota to the south. The enormous crater produced by this evisceration of the mountain measures at least six miles in diameter, being one of the largest known—certainly among those the date of whose formation is recorded and unquestionable. The external slopes which reach to the sea, from which the mountain rises as an almost insular promontory, are composed of the larger blocks of lava and scoriæ thrown up by the eruption. Within the Bay of Fonseca, the Isle of Tigre presents a very regular cone, breached on one side, and composed of basaltic lava and scoriæ. On the opposite horn of the bay to that of Coseguina stands the volcanic cone of Conchagua, likewise basaltic, but shewing no crater at the time of our authors' visit. It has very recently broken out in eruption (February, 1868). A few leagues to the west the volcanic cone of San Miguel, 7000 feet in height, was in eruption in 1849, and discharged a stream of basaltic lava from an opening very near the summit. Its previous eruptions had been frequent, and many other lava streams have descended from it. It has a deep circular crater, about three miles in circumference, with perpendicular walls of solid rock, chiefly basaltic, as are the scoriæ scattered about, but containing many small felspar crystals.

Westward of San Miguel are several smaller volcanic cones, and many very active mud volcanos discharging hot vapours, called by the significant name of the "Infernillos." Next comes the apparently extinct volcano of St. Salvador, having a lake within its crater of a mile and a-half in diameter. It is surrounded by immense accumulations of pumice-conglomerate. Further to the west rises the volcanic cone of Izalco, remarkable from having been thrown up on a spot which was before a level plain, by eruptions of lava and scoriæ, which, beginning in the year 1770, have lasted almost without intermission down to the present time. The height of the cone which, of course, is continually increasing, was, at the time of our author's visit in 1864, above 10,000 feet. Its lavas are basaltic, *i.e.*, pyroxenic, of deep black colour, and highly vitreous, with numerous crystals of glassy felspar and grains of olivine. Our authors ascended it, and found at the summit a vast elliptic crater, or rather three craters together, on a line corresponding with the general volcanic axis of the district. The central crater gave out much vapour from several fissures, especially from one deep and large hole, within which almost continuous detonations were heard. The vapours were chiefly steam, with a mixture of chlorydric and sulphuric acids.

Proceeding further westwards, after passing several smaller volcanic cones, mostly extinct, and other numerous mud-volcanos, we come to the very remarkable group of Pacaya and the volcanos of Fuego and Aqua (fire and water), near the lake of Amatitlan. The first of these consists of several mountainous masses of trachyte, embracing a number of scoriæ-cones and craters. The highest of them reaches nearly 8,500 feet above the sea. In the centre there is a vast semicircular area, evidently the remaining portion of a colossal crater, while two considerable cones, each having a regularly circular crater at their summits, stand like sentinels on either horn of the crescent. One of these contains a circular lake. From the foot of the other cone an immense lava-stream spreads over a wide area of the high plain around. It was produced by an eruption in 1755.

From the summit of Pacaya a favourable view is obtained of the volcano d'Agua, a perfectly regular cone, more than 11,000 feet high, from which descended, in 1541, a torrent of water—the contents, no doubt, of a crater-lake on the summit, which destroyed the old town of Guatemala, and occasioned the removal of its inhabitants to a new site. Next to this, and nearly equal in elevation, is the cone called 'di Fuego,' from the heated vapours still evolved from its summit. This cone, perfectly regular on three sides, presents on the fourth what appears to be a portion of a vast breached crater. Another crater, quite circular, and 1,500 feet in depth, exists on the summit, which is nearly 12,000 feet in height. The lavas produced by both these last volcanos seem to be trachytic, though our authors are unwilling to admit that any of the trachytic porphyries which compose the rocks around these craters are true lavas.

A short distance westwards, a group of three volcanic cones united at their base rise from the southern shore of the lake of Amatitlan (4,560 feet). The largest was eruptive in 1828, 1833, and again in 1852, throwing out vast quantities of ash, with fearful detonations. A great rent in the southern slope of the cone discloses its composition of trachytic conglomerate and massive trachyte. The authors seem even here also to doubt that this rock is the product of the volcano itself, though their description and drawings make it difficult to suppose it to have had any other origin.

Still further westwards, in lat. 14° 50′, we come to the volcanic group of Quezaltenango, consisting of two principal cones, the Cerro Quemado, and Santa Maria, the latter dormant (10,500 feet high), the former in eruption in 1785, and still smoking. Its summit is lower by near 2,000 feet than its sister cone, owing apparently to its having been truncated by the last eruption, which has left a wide crater, rather polygonal than circular, partly surrounded by abrupt cliffs and peaked eminences composed of trachyte, one side having broken down to give issue to a vast torrent of lava, which adheres to the outside of the cone as a buttress-like mass of great size and height above the neighbouring plain. The surface of this lava mass is covered with blocks and scorified peaks. And our authors appear to feel great difficulty in recognizing it as having flowed as lava out of the crater, not being aware, perhaps, that it is a not unusual characteristic of some lavas, especially those of highly crystalline matter, to possess at their escape from the vent a very low degree of fluidity, and also to split and break up superficially into massive blocks, through the rapid consolidation of their surfaces, on the escape of the vapours which they contain in abundance. (See Volcanos, p. 135. Longmans, 1862). The crater of this volcano still gives issue to many fumaroles of acid vapour, which coat its crevices with crusts of sulphur and various sulphates.

Several other volcanic cones are visible from this point, continuing the train of vents into the territory of Mexico, but were not examined by our authors. On quitting them we cannot forbear from expressing regret that they had not entered on the examination of so interesting a volcanic district, free from any preconceived ideas as to the non-volcanic character of the great masses of trachytic porphyry and their conglomerates, which compose its chief substance; and which we must believe to have been closely connected in origin with the volcanic cones and craters that everywhere penetrate its mass and stud its surface. We should then, perhaps, have obtained from them a more definite and clear idea of the geology of this interesting country.

G. P. SCROPE.

II.—THE GOLD-FIELDS AND MINERAL DISTRICTS OF VICTORIA, with Notes on the modes of Occurrence of Gold and other Metals and Minerals. By R. BROUGH SMYTH, F.G.S., Secretary for Mines for the Colony of Victoria, etc., etc., etc. Melbourne, 1869. 4to, pp. 644. Illustrated with One hundred Sketches, Plans, Maps, and Sections. London: Trübner and Co., Paternoster Row.

ONE of the greatest glories of England is her Colonial possessions, and of these Australia is undoubtedly the finest. Less than a century ago this vast continent was virtually a *terra incognita*, its colonization having only commenced in 1789, whilst the organization of its separate governments was only accomplished in 1842.

Mr. Smyth thinks that at the present time, even, the resources of this great country are less known than are those of Tasmania, Norfolk Island, or Japan.

As far as concerns the mineral riches of the Colony of Victoria, the grand work before us furnishes all the information that can be desired, and, although the author modestly speaks of himself as only a compiler, we are bound to say that Mr. Smyth has, by the publication of his book, conferred a service on the Colonial Government and the public, which entitle him to the best thanks of us all.

Mr. Brough Smyth writes, (p. 5):—"During a period of nearly fifty years—from the first discovery of the waters of Port Phillip Bay, in February, 1802, until the finding of gold at Clunes in March, 1850—it was believed that the southern part of the Island-continent of Australia was so much almost useless land, lying in the way of the navigator, and probably profitable only to such hardy pioneers as might take sheep, and cattle, and horses to it from Tasmania and New South Wales."

Every district was valued solely in proportion to the number of sheep, or cattle, which each acre would carry, and although reefs of quartz might be seen, in numberless directions, standing twenty feet above the surrounding surface, every foot of which contained gold visible to the naked eye, they seem to have awakened neither curiosity nor inquiry; whilst the careless shepherd drew water daily from the creek beneath whose bed lay grains and nuggets of gold, far exceeding in value the wildest dreams of "El Dorado." All this is now totally changed. The rapid strides which have been made by this Colony since the opening of the gold-fields in 1851, owing to the vast amount of labour expended in public works of all kinds, and the extensive tracts of country opened up and explored, would seem perfectly incredible, did we not find in the work before us such indubitable evidence of the increase in population, wealth, and material resources of this wonderful region.

Let us take only a few of the facts which Mr. Brough Smyth has collected for our information.

In 1851, the population of Victoria was 77,345 persons; with 57,472 acres of land under cultivation; imports, £1,056,437; exports, £1,422,909.

In 1867, the population was 659,887 persons, with 631,207 acres under cultivation; imports, £11,684,080; exports, £12,724,427.

The value of the mineral produce of Victoria, from 1851 to 31st December, 1868, exhibits equally astonishing totals.

Gold exported[1] 1851 to Dec. 1868, 36,835,691¾ ozs. at 4*l.* per oz.		£147,342,767
Silver-ore raised, 11,348 tons; produce, 18,353 ozs. 8 dwts. at 5*s.* 6*d.* per oz.		5,047
Tin-ore exported, 2,871 tons	£208,725	
Tin exported, 11 tons 8 cwt.	1,239	
		209,964
Copper-ores raised, 855 tons; smelted, regulus, and rough copper		5,800
Antimony, ore raised, 3,662 tons		37,160
Coal, 1,933 tons at 30*s.* per ton		2,899
Lignite, 235 tons at 17*s.* 6*d.*		205
Kaolin, 1,757 tons at 4*l.* per ton		7,028
Flagging-stones, 57,500 square yards	£19,425	
" 1,200 tons	2,100	
		21,525
Slates		648
Magnesite, 6¼ tons at 2*l.* per ton		12
Diamonds, 81 carats		81
Sapphires		150
		£147,633,286

One more item we will give—namely, the total revenue derived directly from the gold-fields by Government in the shape of fees for gold-licenses, miners' rights, rents, etc., which from 1851 to 1868 inclusive, amounted to £5,211,465 19*s.* 1*d.*—a very creditable sum in eighteen years for an infant colony to yield from a single source of revenue.

The Colony of Victoria has a total area of 86,831 square miles, one-third of which (says Mr. Brough Smyth) may safely be assumed to be occupied by gold-bearing rocks. Granite and other Plutonic rocks occupy 2,200 square miles; Basaltic and Volcanic, 10,300; Silurian and Devonian rocks, 27,800; Carboniferous series, 3,200; Tertiary rocks, 28,600; Limestones of all ages, 330; unexplored region, chiefly consisting of Granites and Lower Silurian rocks, 14,401 square miles.

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[1] The quantity of gold used and manufactured in the Colony cannot be estimated.

Let us now for an instant scan the physical features of the country. The Colony of Victoria occupies the south-eastern sea-board of the great Australian Continent, having New South Wales to the north, from which it is divided along nearly its entire frontier by the Murray River, and South Australia to the west.

The great Cordillera, extending southwards from Cape York, culminates at Forest Hill in a peak 5000 feet high, and runs thence in a south-west and west direction through Victoria, turning southwards at St. Clair to Wilson's Promontory. This great chain of mountains, which give off numberless minor chains, spurs, and lateral ranges, has at least thirty principal mountains, many of which are from 5000 to 6000 feet in height, snow-clad at their peaks nearly all the year. The principal ranges conform rudely to the coast-line, dividing the water-shed between a series of minor rivers which flow south and south-east to the coast, and a larger series running north and north-west, which mostly unite with the great Murray River.

Altogether there are sixty rivers in the Colony; of these, the Snowy River has a drainage area of 5000 square miles, the Yarra about 1,500. A tract of 1,144 square miles drains into Lake Korangamite, which is twenty miles in length north to south, and in some parts seven miles in breadth.

Everywhere, beneath flows of basaltic lava, ash-beds, and other volcanic deposits, the miners, in sinking, come upon ancient river-courses and old land-surfaces, the drainage lines often running in the same direction as the present, and hollowed out in the upturned denuded beds of Silurian or Devonian strata.

If arguments were needed to enforce the vast periods of time occupied by subærial denudation in forming and transforming, and carving over and over again the surface-contour of continents, here, in this region, so ably described and depicted in Mr. Brough Smyth's work, we shall find abundance of illustrations. But here, as we have always insisted, not one set of causes have operated to effect these changes, but many. Volcanic and plutonic action have been busy, the sea has been here again and again, and torrents, whose beds are dry, save in the rainy season, have here demonstrated what can be done by *rain*.

We cannot resist giving two or three extracts from Mr. Smyth's work, which has so interested us in its perusal:—

"That part of the Victorian territory which lies to the south of the Great Spur has a better climate than that of the northern area, and its soils are as rich as could be desired. The area of its water surfaces, as compared with other parts of the colony, is considerable, and the numerous bays, lakes, and streams increase the humidity of the atmosphere to an appreciable extent. Both in the high lands at the sources of the River Yarra, and on the plains of the Lake District, the character of the vegetation is altogether different when we approach the well watered parts. Where the soils are deep and rich, and the rainfall is generally heavy and the climate moist, we find trees as large as any in the world. In the deep recesses of the mountains, near the sources of the Yarra, the mountain ash (*Fagus Cunninghami*) attains a height of 300 feet, and the *Eucalyptus Amygdalina* quite 400 feet; and all around is covered with a dense undergrowth of Tree-ferns and shrubs, which overshadow streams that never, even in the driest season, cease to flow.

"Leaving the hot and sultry streets and suburbs of Melbourne in the midst of summer, when the air is like a blast from a furnace and the ground is baked or beaten into dust, we can in a few hours reach a tract which is always green, always moist, and where bubbling streams, fed by mountain springs, flow with noise and sparkles over pebbly beds to the main river,—where the rich green of the fern leaves and fronds mixes in delicate harmony with the less brilliant tints of the sassafras and the musk, and where steep and lofty mountains, even in mid-day, cease not to cast their shadows over the clefts whence the waters take their rise (p. 16).

"The country to the east is mountainous, with here and there majestic masses of granites and schists. The higher peaks and passes are covered throughout a greater part of the year with snow, and are nearly always capped with clouds. Turbulent streams run through narrow gorges, and dense foliage extends from the flats to a height of nearly 3,000 feet. On the higher parts, where vegetation is nearly absent, or poor and scanty, we find, in the colder seasons, but bare rocks, snow, and ice-bound streams, and, in the spring, much that reminds the Victorian traveller of almost forgotten Alpine scenery. Towards the west and north-west the country is low and level, the streams are sluggish, the rainfall is uncertain, and but small in amount; the summer season is intensely hot, and the evaporation is ordinarily so much in excess of the natural supply from the heavens, that lakes and waterholes in many places present an appearance suggestive of great cyclical changes in the climate" (p. 15).

The Victoria' the Serra, and the Grampian ranges are composed of vast masses of thick-bedded sandstones, probably of Upper Palæozoic age. "Bold, abrupt cliffs of a somewhat peculiar character, due to the horizontality of the beds, give a marked character to the landscape, and the rather smooth outlines where the rocks have worn away gradually in the trend of the streams, present pictures which are delightful to the eye of the artist. The peaks of Mount William, on the edge of the Palæozoic mass and abutting on granite, are as high as 5,000 and 6,000 feet, but in the Dundas range, further westward, the hills are not higher than 1,524 feet" (p. 11).

Here is a description of a Salt lake, the origin of which seems due to volcanic action:—

"Gnotuk, the waters of which are about 130 feet below the level of Bulleen-Merri, is bitterly salt. The drainage area is small, and it receives but little rain water, and is only slightly fed by a spring issuing from a sloping bank which divides it from its neighbour. Even here we find fish and a few brackish water shells.

"Dead trees stand in the water near the margin of the lake, and the soft mud is full of the bones of animals which have perished on its shore. It is a sad and solitary spot. Steep banks surround it, sombre gum trees give a cold colouring to its margin, but slightly relieved here and there by the brighter tints of the lightwood; carrion birds wheel over its still waters, and the whole has a weird aspect, but is yet full of beauty—a picture which the conventional artist would disregard, but one which the trained student would study with delight and profit. Cocoolite and fragments of topazes are strewn along the floor in many places.

"Mr. H. Cadogan Campbell, when he was stationed at Warrnambool, had an opportunity of observing the strata sunk through in a well on the south-eastern slope of the margin of the lake. They sank first through about three feet of soil, and then for about sixty feet passed through layers of ash, alternately black and white, and of irregular thickness, though none above an inch or two. At the depth of sixty-three feet the workmen came upon the original surface of the ground, which was covered with *the common coarse grass now found growing. It was not scorched, but merely dry, like hay.*[1]

"Underneath the ancient grass-clad surface the workmen sank sixty feet through a blue and yellow clay. It was in sinking this well that the skull and some other bones of the Dingo, or wild-dog, were found, being the first decisive proof that this animal is indigenous" (p. 20).

Space does not permit us to prolong our notice of this very interesting work, which possesses much information for the Mineralogist as well as for the Geologist. To the practical miner in Australia, the book will prove of the utmost value, and it cannot fail to be read with interest and profit by all who either intend to make mining their study, or are already pursuing it as a profession, in whatever part of the world they may be located. The illustrations, maps, and sections are admirable, and reflect the highest credit, as also does the topography, upon our Colonial artists, engravers, and printers.

III.—Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Edited by Professor T. Rupert Jones, F.G.S. May, 1869. 4to. Part IX. London: H. Baillière.

We noticed the previous part of this work in our June number, and are glad to receive another instalment towards the completion of this important publication.

In the part now before us, Dr. Paul Broca continues and concludes his examination of the skulls and bones from the Cave of Cro-Magnon.

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[1] [See Quart. Journal Geol. Soc. London, 1867, p. 227.]

Prof. Broca first treats of the limb-bones, and controverts the opinion, expressed by Dr. Pruner-Bey, that certain peculiarities in the conformation of the tibial bones was due to their having been deformed by "rickets."

Against this Dr. Broca cites the fact that the limb-bones of the "Old Man" found in this Cave which, if affected by rickets, ought to have been stunted and misgrown, were really remarkably well developed and indicated a man not less than six feet in height.

The individuals found interred in this Cavern are three in number—an old man, an adult man, about 45 years old, and a woman, 35 to 40 years of age. The skulls are highly dolichocephalic (long-headed), but are nevertheless of large capacity; the face is broad, the ascending ramus of the lower jaw enormously developed, the surfaces for muscular attachments extensive and rough, especially for the masticatory muscles; giving rise to the idea of a violent and brutal race. To this may be added the athletic conformation of the bones, and particularly the extraordinary prominence on the femur, giving evidence of great muscular development.

One of the thigh bones of the old man presents an old indentation, made during life, which has forced the compact outer layer of the bone into the spongy interior, without breaking the whole bone. Such an injury may have been inflicted in early life by a sling-stone, or other smooth projectile, or by a blow of a horn or antler, or of an elephant's tusk.

The skull of the woman had been cleft open, or rather penetrated, above the left orbit, by a blow from some sharp implement, probably, from the form of the wound, a small stone axe. This injury, which doubtless produced death, was nevertheless not immediately fatal, as an examination of the wound shows a vascularity of the bone and a deposit of finely porous bony matter, which must have required from fifteen to twenty days for its production. As there is no splintering of the table of the skull, the blow must have been given with great force. If the old man was merely wounded in the chase, there seems to be conclusive evidence that the woman's wound was inflicted in a murderous assault made upon her, either by one of her own family, or in an attack of some neighbouring hostile tribe.

These early Cave-men, writes Prof. Paul Broca, appear to have combined, with great intelligence—as evidenced by the works of industry and art they have left behind—"the physical force and habits of war and the chase, which alone at that time could assure subsistence and security. At the present day, with our powerful metals, our terrible arms, and our country long since cleared—with all the resources furnished by agriculture and commerce, we can live peaceably the life of civilization; but when immense forests, which the axe of stone could not fell, covered the greater part of the soil, and, instead of agriculture, hunting only could provide sustenance for man, when the immediate wants of life necessitated a constant war against wild animals, such as the Mammoth, and when at last the hunting territory, the sole resource of a tribe, had to be continually defended against the encroachments and attacks of neighbouring tribes, men were obliged, under pain of destruction, to accommodate themselves to circumstances, and live the violent life of savages."

"The Cave-dwellers of Cro-Magnon were then savages, like all men of their time; and we are not astonished that such conditions of existence have left strong traces in their skeletons.

"But these barbarians were intelligent and improvable; and whilst continuing to struggle with Nature and to war against their kind, they knew how to make leisure enough to increase their knowledge, to develop their industry, and, still further, to rise to the culture of the arts. These aptitudes, so precious—rare at all epochs, but truly extraordinary at the time they were manifested among these Cave-folk—could not have dawned but by favor of a fine cerebral organization, of which we have found the morphological expression in the skulls of the Cro-Magnon race."—(p. 120–121.)

In the following chapter M. de Quatrefages, Prof. of Anthropology in the Museum of Natural History, Paris, offers some further critical remarks on these Cro-Magnon remains.

This is succeeded by 8 pp. of Description of the tinted Plates of Flint Implements, four of which accompany the present part, and two Lithographed sketches on the Vezère, taken by W. Tipping, Esq., M.P., F.S.A., in May, 1867.

The first sketch, "View of the Château des Eyzies," is very interesting, both pictorially and Archæologically. "This fine old ruinous Château, parts of which have been excavated in the rock against which it is built, stands at an angle to the south-west of Les Eyzies village, near the junction of the Beune with the Vezère."

The second sketch, "View of Le Roc de Tayac," is that of a much excavated escarpment, opposite the church of Tayac, and still contains many chambers and galleries of an old stronghold, hollowed out of the rock, with occasional openings and vertical passages leading from higher to lower chambers.

To the Archæologist, the Geologist, and the Artist-Tourist, in search of the picturesque and romantic, this Valley of the Vezère will be found full of interest, and well deserving of a visit.

IV.—THE SCENERY OF ENGLAND AND WALES: ITS CHARACTER AND ORIGIN. By D. Mackintosh, F.G.S., etc. 8vo. 399 pages; with 86 woodcuts. London: Longmans and Co.

WHEN Man first thought about the earth as bearing on its face the signs of past and present alterations, in the outlines of seas and lakes, the increase and decrease of shoals and islands, and the course and deltas of rivers, he saw in *water* the mighty agent of the change. The tropical rains, too, and especially the rare but violent rain-storms of dry countries, such as Persia, with their torrents and destructive floods, shewed its awful power still more vividly. Had this been all, he might have been satisfied with the thought that the rain and sea were ever destroying the hard primeval land, and grudgingly yielding back a narrow sand-bank and swampy delta here and there, until all should be engorged by the tyrant ocean: or the dreamy thoughts of some would fancy the aged earth fretting away and disappearing in the great sea's womb, whence the divine fiat had called it forth at first. But other thoughts came in—the sandstones and loams of hill and vale had too strong a likeness to the sand and mud of shore and bank, not to be associated with them in some observing minds; and the fossil shells of the high grounds demanded water as the cause of their deposit there, for they were like the living creatures of the sea. And here, the floods of rain and rivers, and, may be, the storm-flood and earthquake wave of the coast, were too strong in the memory of individuals and races not to supply what seemed to be a true cause for the heaping up of sea-spoils on the hills, mingled too, as they sometimes are, with bones and teeth of land animals. This imperfect notion of the part played by water on the earth—misdirected too from a strict study of natural phenomena into legends of fear and wonder—misled the mind into the false and easy path of error, taking it for granted that the sea came and went over all the earth, with more than the destructive force of all the torrents and all the floods that ever could be thought of. Even at the present day the tyro in geology falls readily into the same line of thought, when told that the limestone of the hill-top consists of sea-shells, —"Oh, yes, because the sea was here," he says; not thinking at first but that the configuration of hill and dale was always what it is at present, and having yet to learn that the old shell-bed, now cut up as outliers on separate hills and plateaux, was once continuous, and as far below the water-level as perhaps it is now above it. "The sea was here" is true enough in one sense; it was in the district, this region; but was it at this height, over this hill-top? No. When the sea was here there was the usual sea-bed of ooze, or of silt, or of coral-reefs, or shell-beds, or of sand and shingle, near to or far below the water-level, as the case may have been; and subsequently, when this region of the globe was in its turn upraised (either by the swelling of hot rocks, and water changed to steam in the fissures of the earth below, or by the crumplings due to the pressure of local contraction and subsidence), it rose out of the sea,—but in what shape? If it rose slowly for years and centuries, it must have yielded a heavy tribute for its escape into the bright air; for the active servants of the sea, the cruel waves, ceaselessly persecuted its heaving back, wearing away the sides of each rocky protuberance with grooves, notches, caves, and cliffs, often faintly marked, and merging into a general sloping flank, but sometimes deeply engraved, as a permanent record of the ever-active waves, gnawing at one level during a long rest in the upward movement of the land. How far this horizontal eating of the waves, or planing action of the sea, could extend over a land at rest, we cannot tell: so much depends on conditions favourable for the removal of the shingle, sand, and other débris, which, remaining, would check the sea's advance. Some think they have discerned such broad flat planing over elevated continental areas, or at least through vast regions marked out by even-topped mountains far above the sea, and by plateaux of equal height, now scattered over the field of vision, and disconnected by the loss of intermediate ground, once flat and high, but since furrowed and removed by the slow and unaided action of rain or glaciers. Others would refer the uniformity of the mountain-heights to the general level of the old upraised ocean-floor, and assign to the ready wave-line of the grudging sea the credit of removing the original soft material of the surface, as well as much of the hard rocky matter, along the many lines of shrinkage-crack, of fissures due to contortion, and other dislocations of the upheaved strata, until the sea was left behind; and then the air, the rain, frost, snow, and glacier were left to do their work in moulding both cliff and incline of the new land into highlands and lowlands, rugged or smooth, steep or sloping, bare or verdant, according to the nature of rock and climate.

In former days, many a book was written about the effects of a supposed universal deluge in modifying the contours of any part of the globe; but though they became waste paper, the idea of oceanic action having wholly caused the outlines of mountain and valley lived on, until the thoughts of such acute observers as Hutton gave life to the modern science of geology, and each of nature's agents—the chemical action of the air, the ripping frost, the grinding glacier, the soaking rain, and the rushing torrent, as well as the pounding waves and shifting tides, had each their claim allowed them. It is, then, to all of these, in their manifold diversity of operation, that the Denudation or stripping bare of the exposed surface of the earth is due; but to what degree one set or other of the agencies have done their work, in any given region, cannot be determined without a knowledge of its geological history and structure, and without an acquaintance with all the phenomena consequent on the separate or combined action of the said agencies on different rocks under different circumstances. In so wide a field of research, there are many observers, and not a few record their views or the results of their work. Several members of the Geological Survey of Great Britain and Ireland, much occupied in field work, have been strongly smitten by the force of rain and moved by the vehemency of ice-action; and hence bold theories have been advanced and defended by them, wherein the atmospheric powers are so mighty that great Neptune would appear to have been forgotten, were it not that to him has been apportioned the remote and almost inconceivable work of planing down the risen continent, for Æolus, with his wind and rain, to fret into the many-featured lands. A waiting belief, however, that the work of denudation should be more equally divided, seems to have survived among other geologists, who write in the GEOLOGICAL MAGAZINE and communicate with the Geological Society. And indeed, foreign geologists seem still to be actuated by the usual belief that the retreat of the sea originated the main furrows and slopes on the land, and that rivers have long been filling up many of the larger valleys, whilst cliffs are being made along the slopes that stay at the wave-line.

In the work before us, a well-thought effort has been made to trace the nature of the geological causes, especially Denudation, by which the physical features of England and Wales have been produced. The author appears to have no personal acquaintance with foreign lands; therefore he refers to others for facts and notions regarding the Denudation of Norway, Switzerland, and other Alpine countries; but in England and Wales he seems to have visited, and sometimes resided in, the places from which he gathers the grounds of his information and the illustrations of his views. Though not a professional field-geologist, but by occupation, as he says, a "lecturer on geology, etc., to provincial scientific institutions and schools," Mr. Mackintosh has evidently prepared himself for geological research, and is well read in Modern British Geology, at least; and in his book he is careful to refer to the authors treating of the points and questions with which he concerns himself. His own views of the nature of Denudation incline him to lay much stress on marine action as having left its mark on the surface-features of all countries; and he says that the main object of his book "is to trace and describe those peculiar forms of surface-configuration which point to the sea as having been concerned in their formation, not, however, overlooking the effects of rivers, rain, frost, and ice." In a systematic and painstaking manner does the author treat of the difficult subject of denudation, in all its modifications, as seen in England and Wales, and described by Darwin and other good observers in distant lands; and certainly he keeps in view "the importance of taking nothing for granted, and the necessity for collecting facts, and attaching little importance to theories;" and thus, giving credit to atmospheric action to a very great extent, he never loses sight of what the sea could do, and indeed in many cases must have done, while the land was rising and sinking, and rising again through storm-tossed and tidal waves, for at least 1,400 feet, as shown by the Post-tertiary beds on Moel Tryfaen. In his application of these various forces to the long-continued and manifold operations, the results of which we see in terraces, coombs, cliffs, escarpments, tors, pillars, arches, rock-basins, lakes, rivers, cataracts, valleys, plains, hills, mountain-peaks, and other features, fashionings, and characters of our country and of other regions, he conscientiously strives to emulate (though not agreeing with him on all points) the eminent Denudationalist, Professor Ramsay, of whom he says "I have reason to believe that, like a true philosopher, he would vary his explanation to suit diversity of internal structure and surface-configuration;" and in no less degree does he aim to follow the veteran Murchison (to whom he aptly dedicates his book) in being guided in his researches "by an appeal to Nature, irrespective of prevailing theories."

After some general remarks on Denudation, Mr. Mackintosh describes, in some detail, the denuding action of the sea on the coasts of England and Wales, especially of tidal currents and sea-waves. The inequalities and forms of rock-surfaces under sea-water are then described; the forms of sea-beaches; the cliff-lines, with their caves, grooves, arches, needles, stacks, and other varieties of cliff-architecture; and, lastly, the forms of maritime inlets, are succinctly treated of.

Some pages are next occupied with remarks on the Denudation that must have occurred during the "Glacial" and other submergences of England and Wales, inasmuch as the gravels and shingle of the "Glacial" and "Post-glacial" periods remain as visible débris of sea-worn lands. But it appears impossible as yet to determine from these so-called "Drifts" how many emergences and submergences there were, or how much wrecking of the land the mass of detritus really indicates; some of the oldest of these "drifts" may have been shifted again and again, "serving as shore-accumulations for seas in the depths of which some of our finer sedimentary strata may have been deposited," just as the pebbles of earlier shingles were left to rest awhile in old conglomerates, to be loosened and sent again by wave or stream to another and perhaps another place of heaping-up or of out-spread driftage.

Holding in mind the main object of the book, namely, the explanation of land scenery, the author then seeks to apply the facts of marine scenery, already studied, to the explanation of inland features. He prefaces this part with some well founded remarks on the extent to which different rock-structures give rise to difference of landscape; relative (not absolute) hardness of the several strata, and their variously horizontal, inclined, or vertical positions being the causes of differences in surface-aspects, combined with lithological conditions favourable or otherwise to the growth of this or that kind of tree and herbage. Some raised sea-beaches and inland terraces, chiefly in the south of England, are noted, and a reference made to their being evidences of sudden displacement of the land whilst being fed upon by the sea. Inland escarpments come next, and occupy six interesting chapters well worth reading and careful consideration. The history of the Wealden Denudation is concisely handled, but would be more perfect if allusion had been made to Mackie's bold suggestion of a tidal stage in the long process of that old excavation, when the North Downs still reached across, as an isthmus, to the chalk of France, and the checked tide swept in and out along the curving cliffs ("Geologist," 1860, p. 203). But not only the Cretaceous escarpments, but those in the Oolitic counties, and those of the Lias, the New Red Sandstone, Coal-measures, Millstone-grit, Mountain-limestone, Old Red Sandstone, and the Silurian and Cambrian rocks, are brought forward with much care, and often shown in woodcuts. Then come the granite tors and rock-basins, the coombs (cwms) and tarns, and the questions as to how far they are generally and individually due to the rain or springs or glaciers, or to the sea and coast-ice. Conical isolated hills are briefly noticed; and then the marine origin of plains, both of upland plateaux and of many low-lying plains, at least as regards their original general flatness, is insisted on, apparently with justice. The classification and origin of valleys, gorges, gulleys, and passes, are dealt with in two chapters, full of interesting discussion, based on observations

made in the Southern, Western, and Midland Counties, in the Lake District, and in Wales, by our author, with the eye of a *marinist*, in contrast with the deductions of the *aërialists*, such as Greenwood, Jukes, Geikie, Whitaker, Topley, and Foster. The denuding action of freshwater streams, rain, and ice, is briefly treated of in chapter xv.; and for this island at least, with its existing climate, the author gives little credit to rivers for removing much matter from the higher levels.

The remaining portion of this interesting book is occupied with a series of excursions (in Wales, Devon, Midland Counties, Shropshire, and the Lake District), treated in a popular style, sometimes as popular lectures, with a freedom in sub-poetic talk, in which the many interesting points of inland scenery are explained with reference to geological structure and to denudational views as adopted in this work; and for those who either must, or wish to, learn something about hill and valley, shore and stream, besides what the whisperings of geology in general literature tell them, we strongly recommend this well-attempted manual of denudation, together with Geikie's "Scenery of Scotland;" and when their learning shall have reached some firm standing, let them go among the mountains and the valleys, and give at least as enthusiastic and as welcome aid to the progress of geology as this now offered by Mr. Mackintosh.

V.—TRANSACTIONS OF THE WOOLHOPE NATURALISTS' FIELD-CLUB. 1867, pp. 190; 1868, pp. 278. Hereford: *Times* Office. 1868 & 1869.

ONE of the healthiest signs of the steady progress of the study of Natural History is to be found in the increasing activity of our provincial scientific societies, and in judging of the good work done by those excellent institutions, the Woolhope Naturalists' Field-club has especial claims for our hearty congratulation. Established in 1851, it issues annually a volume of Transactions, and the two handsome volumes under notice are excellent both in respect of matter and illustrations. The reports and papers read at its meetings are published from time to time in the *Hereford Times*, which, reset in octavo, form the Transactions of the Club; and in this manner the Society, with a small annual subscription of ten shillings, is enabled to issue its yearly volume, with numerous illustrations. Noticeable among the papers in the annual report for 1867, is one on Upper Silurian Fossils, by the Rev. R. Dixon, illustrated with some effective sketches of *Actinoceras baccatum*, and other Cephalopoda; the geology of the Woolhope district is also considered by the same author. Mr. Jebell furnishes a careful report of the meteorology of the year, and Dr. Bull contributes an interesting paper on the edible funguses of Herefordshire, provided with coloured drawings of those luxuries and recipes for cooking them. *Lactarius deliciosus* Dr. Bull tells us "to fry in slices, properly seasoned with butter or bacon and gravy, and serve up hot with sippets of toast. A steak in addition is a great improvement." The *Glanz-punkt* of both these volumes is a series of photographs of the remarkable trees of Herefordshire, which are deserving of a more general circulation.

The volume for 1868 contains two fine photographs of *Cephalaspis asterolepis* and sketches of the unqiue specimen of *Stylonurus Symondsii*, found at Rowleston Hill, and of *Homalonotus Johannis*, with descriptions by the late Mr. Salter. There were several interesting contributions on the geology of the neighbourhood sent in during the year, to which, however, we are unable to do more than direct attention. Dr. Bull, who continues his interesting paper on the funguses, explained the discovery of Silurian fossils at Wicton, and the President, Dr. M'Cullough, the characteristics of the Cornstones of Herefordshire and Monmouthshire. Mr. G. Phillips Bevan, F.G.S., read a paper on the South Wales Coal Field, and the Rev. W. S. Symonds, the President of the Malvern Naturalists' Field-club, one on the geology of the district. A few palæontological notes on the Silurian strata of the Woolhope Valley were contributed by the Rev. P. B. Brodie, the Vice-President of the Warwickshire Naturalists' Field-club. Mr. Salter supplied a description of *Pterygotus taurinus*, discovered by himself and the President in the quarry at Ewyas Harold, near Pontrilas. Papers on British Snakes and Roman Roads, Mason Wasps, and Fairy Rings, and a host of other subjects, with reports, meteorological and financial, make up the volume. There is a tendency on the part of some of the authors to indulge too freely, perhaps, in quotations from the Poets,—a practice in the exercise of which too great caution cannot be observed. The contributions are, as a rule, unusually free from errors; in the address of the retiring President for the year 1868, however, we are astonished to find the names of Sir John Lubbock and Professor de Morgan amongst those "of men whom we never again shall speak of as being amongst us."

VI.—FIGURES OF CHARACTERISTIC BRITISH FOSSILS, WITH DESCRIPTIVE REMARKS. By W. HELLIER BAILY, F.L.S., F.G.S., Acting Palæontologist to H. M. Geological Survey of Ireland. Part II. Plates 11–20. Lower and Upper Silurian. 8vo. pp. 43. London: John Van Voorst. 1869.

WE noticed the first part of this useful work in the GEOLOGICAL MAGAZINE, 1867, Vol. IV., p. 464. Although a long interval has elapsed between the appearance of these parts, Mr. Baily informs us that he has now made arrangements for its more rapid completion, which we rejoice to hear. The work is so important a one that we are anxious to see more of it; indeed, it is one which the Palæontological student must possess for himself, therefore we think it only needs to be made known in order to be sought after and subscribed for. The descriptive letter-press in each part is both palæontological and geological. Commencing in Part I. with the Cambrian rocks, we learn their lithological characters and geographical distribution, and figures are given of recent *Hydrozoa* for comparison with *Oldhamia;* and again in the Silurian we have figures to illustrate the structure and parts of a Trilobite, to render the plates of Silurian forms more intelligible. In referring to the Graptolites we have quite a number of forms of *Virgularia*, *Sertularia*, etc., given as recent illustrations.

In the descriptive remarks on Corals in Part II. we have figures in the text to explain the several parts of a Coral and its mode of reproduction by budding from the calice, the side, the base, or by fission; also the distinction between Palæozoic and Neozoic types of corals are plainly shown by diagrammatic woodcuts.

Again, under the descriptive remarks on the Crinoids, we find the same useful method of teaching introduced, so that one afterwards readily seizes upon the leading features in a description of any particular species or genus.

The lithographic plates appear brighter and sharper in Part II., which we take to be a sign that even a distinguished palæontologist and draughtsman like Mr. Baily goes on improving, like good old port; but we hope to have occasion to enjoy the pleasure of recording the issue of fresh parts of Mr. Baily's work more often than we have of tasting "thirty-four."

VII.—Geological Dynamics.

By Sir William Thomson, LL.D., F.R.S.

[Reprinted from the Transactions of the Geological Society of Glasgow, vol. iii., part ii.]

Part I.—*Reply to Professor Huxley's Address to the Geological Society of London, of February* 19, 1869.

In his Anniversary Address to the Geological Society of London, Professor Huxley directed attention to two sentences in a lecture on "Geological Time," delivered by Sir W. Thomson. They were as follows:—

> "A great reform in geological speculation seems now to have become necessary. . . . . . It is quite certain that a great mistake has been made—that British popular geology, at the present time, is in direct opposition to the principles of natural philosophy."

In the first place he endeavoured to show that, even if geological time were limited to 100,000,000 years (a period to which Sir W. Thomson's calculations tend to show it may be restricted), no great reform in geological speculation would become necessary, and that the limitation may be accepted *without* a complete revolution in our ideas. Thus: estimating the total thickness of stratified rocks containing traces of life to be 100,000 feet, Professor Huxley shows that the whole thickness might have been deposited in 100,000,000 years, at the rate of $\frac{1}{1000}$ of a foot, or say $\frac{1}{83}$ of an inch, per annum. In the second place, he examined the arguments upon which Sir W. Thomson's calculations were based, and pointed out that if the data upon which they are founded are loose and uncertain, as he himself admits, no amount of mathematical accuracy can render the deductions drawn from his calculations of any serious import to the geologist.

Professor Huxley asked whether it had ever been denied that the period to which Sir W. Thomson restricted geological time may be enough for the purpose of geology, and remarked that on him rested the *onus probandi* of his call for reformation. Accordingly Sir W. Thomson now brings forward evidence to support his statement, consisting of several passages from the works of Darwin, Jukes, and Page, wherein the necessity of unlimited time is taught. On the other hand, he quotes Professor Phillips' careful estimate of 96,000,000 years for the antiquity of the base of the stratified rocks, which agrees so remarkably with his own conclusions, and also quotes Mr. A. Geikie, who lately declared his opinion that all the erosion of which we have monumental evidence in stratified rocks, and in the shapes of hills and valleys over the world, could have taken place several times over in the period of a hundred million years.

Professor Haughton, whilst admitting Sir W. Thomson's restriction of time, expresses his belief "that the time during which organic life has existed on the earth is practically infinite, because it can be shown to be so great as to be inconceivable by beings of our limited intelligence," and, bearing this in mind, we do not see anything objectionable in the following passage from Darwin, which is quoted by Sir W. Thomson:—he who "does not admit how incomprehensibly vast have been the past periods of time may at once close this volume." Sir W. Thomson denies that he took Uniformitarianism to be the representative of geological speculation in general, he attacked it, but he did not attack geological speculation in general. The Evolutionism of which Prof. Huxley approves, he "always considered to be the substantial and irrefragable part of geological speculation."

Prof. Huxley doubted whether any geologist at the present day would be found to maintain absolute Uniformitarianism, to deny that the rapidity of the rotation of the earth may be diminishing, that the sun may be waxing dim, or that the earth itself may be cooling, and expressed the opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits.

Sir W. Thomson asks on what calculation this opinion is founded, and adds that:—"Fourier's theory of the conduction of heat renders it almost impossible to escape the conclusion that, if the earth has been solid and habitable continuously during the last 50 million years, its rate of increase of underground temperature per metre downwards must have been very sensibly more rapid 50 million years ago than now. The more recently discovered laws of thermodynamics render it certain that the sun must have been something very different 50 million years ago from what he is now; and almost certain that he must have been then very much hotter.

"There is," he continues, "surely good ground for Sir Roderick Murchison's opinion that metamorphic causes have been more active in ancient times than at present, because of more rapid augmentation of temperature downwards below the earth's surface; and it cannot be reasonably urged that a hotter sun is not a probable explanation of the supposed warmer climate of the palæozoic ages." Whilst willingly agreeing with Sir W. Thomson that metamorphic action at depths beneath the surface may have been accelerated in the earlier, or pre-Cambrian times, still we cannot suppose it possible that such rocks now remain to tell of such increased telluric action. As regards the assumed warmer climate in palæozoic times, we see no palæontological grounds for such an inference.

It was suggested indeed by a pseudo-geological writer, some time ago, that the bony armour of the Devonian and Silurian fishes was given to protect them from the *hot water* of those early seas; but as the writer was neither a chemist nor naturalist, his opinion will not assist Sir W. Thomson.

Sir W. Thomson replies at some length to Prof. Huxley's examination of his arguments. The Professor, after pointing out that tidal retardation can be checked and overthrown by temporary conditions, asks "What becomes of the confident assertion, based upon the assumed uniformity of tidal retardation, that 10,000,000,000 years ago the earth must have been rotating more than twice as fast as at present, and, therefore, that we geologists are 'in direct opposition to the principles of natural philosophy,' if we spread geological history over that time." Sir W. Thomson answers "that tidal retardation cannot be permanently overthrown by temporary conditions; that its true amount may be considerably greater than that which we have estimated from the theory of the moon's motion; and that from million of years to million of years it must always be a positive retardation."

We could have wished for a more explicit reply to Prof. Huxley's objections, which appear to us to remain practically unanswered.

Professor Huxley asks if the cooling of the earth has been uniform, considering an affirmative answer to be necessary to the validity of the calculations on which Sir W. Thomson lays so much stress? To this Sir W. Thomson gives a negative answer, stating that investigation shows the greater rate of conduction of heat outwards in past times, and demonstrates a much closer limit for the whole time during which the earth has been solid, and continuously cool enough at its surface to be habitable without break of continuity of life, than can be estimated without taking into account the deviation from uniformity which he (Sir W. Thomson) asserts.

His calculations, he acknowledges, depend only on the assumption, that through geological history the temperature of the upper surface of land and water has been suitable for such life as now exists on the earth.

Although the limitation of time proposed by Sir W. Thomson may not of itself cause so great a revolution in geological speculation as some of the other considerations he has brought into notice, the general tendency of his observations is to support the teaching of Kant, upheld by Professor Huxley—"He reasons back to a beginning of the present state of things; he admits the possibility of an end." There can be little doubt that the school which Professor Huxley terms "*Evolutionists*" will eventually absorb both the modern "Uniformitarians" and the older "Catastrophists."

Part II.—*On the Origin and Total Amount of Plutonic Energy.*

The store of energy to which the phenomena of volcanoes, earthquakes, and subsidences are due, is properly called plutonic energy.

In modern physical dynamics the performance of work may be described as the drawing of energy from one store and laying it out elsewhere. Any irreversible transformation of energy is called a dissipation of energy.

Plutonic action is to be defined as any transformation of energy going on within the earth, but it also involves something in the way of dissipation of energy. The phenomena of volcanoes and earthquakes probably give rise to much less dissipation of energy than the continual silent action of the conduction of heat outwards, the amount of which may be estimated in a thoroughly definite manner. It is found that from year to year the earth, at the present time, is parting with heat at the rate of 92 horse-power[1] per square kilometre.[2]

The store of energy (transformations of which constitute plutonic action) consists almost entirely of terrestrial heat. This, indeed, is the only description of energy proved to exist, in any considerable quantity, within the earth; but it is possible that there may be great masses of uncombined chemical elements, and that the potential energy of their mutual affinities may constitute a considerable portion of the plutonic energy in store, whether for the generation of future underground heat, or for immediate application to some of the more violent manifestations of plutonic activity.

Sir W. Thomson remarks that we have strong reason to believe the earth is not a mere thin shell filled with melted material of rock or metal, but is solid from surface to centre, with the exception of comparatively small spaces still occupied by fluid lava, or subjected occasionally to melting in volcanic action.[3] He concludes that it is not at all probable that there is now within the earth a hundred times as much heat as that which would raise a quantity of average surface-rock equal in mass to the whole earth from zero to 200° Cent., since this would be certainly many times more than enough to melt that amount of any kind of surface-rock under any moderate pressure.

Inasmuch as energy is being continually lost from the earth by conduction through the upper strata, the whole quantity of plutonic energy must have been greater in past times than at present. Sir W. Thomson states that the only probable hypothesis in regard to its origin is that the earth has become warm by the conversion of mutual potential energy, whether of gravitational, or gravitational and chemical, attraction between its parts, into heat.

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[1] One horse-power is a rate of performing work equal to 33,000 foot-pounds per minute.

[2] Kilometre = ·62138 of a British statute mile.

[3] On this subject see the valuable papers in the GEOLOGICAL MAGAZINE, by Mr. G. Poulett Scrope, Vol. VI., p. 145; M. Delauny, Vol. V., p. 507; and Mr. D. Forbes, Vol. IV., *1867*.

Part III.—*Note on the Meteoric Theory of the Sun's Heat.*

In this short note Sir W. Thomson gives his reason for concluding that meteoric supply for sun heat has not, within historical periods, come from distant space outside the earth's orbit. He regards it as highly improbable that the heat of the sun depends at all for its continuation upon a perpetual meteoric supply. In the present state of science, what appears to him most probable are Helmholt's views—that the sun originally acquired his heat in being built up out of smaller masses falling together and generating heat by their collision, but that at present he is simply an incandescent mass cooling.

REPORTS AND PROCEEDINGS.

Proceedings of the Warwickshire Naturalists' and Archæologists' Field-club, 1868.—At the Annual Winter Meeting, held on the 20th February, 1868, the Rev. P. B. Brodie, M.A., F.G.S., Vice-President and Hon. Sec. of the Club, read a paper entitled "A Sketch of the Lias generally in England." Especial reference was made to the lower division in the counties of Warwick, Worcester, and Gloucester, and a particular account was given of the fossils. Mr. Brodie remarked upon the great uniformity of lithological character of the Lias taken as a whole; even certain Zones may sometimes be as readily recognised by this feature as by their zoological contents. The Insect-limestones, which occur at the base of the Lower Lias, immediately overlying the White Lias (Rhætic), and which consist of from two or three to five or six beds of limestone, have been identified by Mr. Brodie in Somersetshire, Gloucestershire, Warwickshire, and Leicestershire, where they present the same mineralogical character, and contain similar fossils. The remains of insects and also of plants are of considerable interest, because they afford the only evidence of terrestrial life in the Lias. The former occur in the Upper Lias, and in the "Insect limestones" of the Lower Lias. Well preserved remains have been met with in the Cotham marble at Aust Cliff, but are not known elsewhere on this horizon. Mr. Brodie speaks of this marble as the probable *equivalent* of the White Lias in Somersetshire; it undoubtedly belongs to the series, but should rather be called the *representative.* It occurs at the base of the White Lias in the Railway cuttings at Saltford, near Bath. The Summer Meeting of the Club was held at Oxford, in June, 1868. Numerous sections in the neighbourhood were inspected under the guidance of Professor Phillips and Mr. Parker. An interesting account is given of the visit, which lasted several days.

Boston Society of Natural History, June 18th, 1869.—Prof. Cope exhibited the almost perfect cranium of a Mosasauroid reptile, the *Clidastes propython.* He explained various peculiarities of its structure, as the moveable articulation of certain of the mandibular pieces on each other, the suspension of the os-quadratum at the extremity of a cylinder composed of the opisthotic, &c., and other peculiarities. He also explained, from specimens, the characters of large new Plesiosauroid from Kansas, discovered by Wm. E. Webb, of Topeka, which possessed deeply biconcave vertebræ, and anchylosed neural arches, with the zygapophyses directed after the manner usual among vertebrates. The former was thus shown to belong to the true *Sauropterygia*, and not to the *Streptosauria*, of which *Elasmosaurus* was the type. Several distal caudals were anchylosed, without chevron bones, and of depressed form, while the proximal caudals had anchylosed diapophyses and distinct chevron bones. The form was regarded as new, and called *Polycotylus latipinnis*, from the great relative stoutness of the paddle.—He also gave an account of the discovery, by Dr. Samuel Lockwood, of Keyport, of a fragment of a large Dinosaur, in the clay which immediately underlies the Clay-marls below the Lower Greensand bed in Monmouth County, New Jersey. The fossil represented the extremities of the tibia and fibula, with astragalo-calcaneum anchylosed to the former, in length about sixteen inches; distal width fourteen. The confluence of the first series of tarsal bones with each other, and with the tibia, he regarded as a most interesting peculiarity, and one only met with elsewhere in the reptile *Compsognathus* and in birds. He therefore referred the animal to the order *Symphypoda*, near to *Compsognathus* Wagn. The extremity of the fibula was free from, and received into a cavity of the astragalo-calcaneum, and demonstrated what the speaker had already asserted, that the fibula of *Iguanodon* and *Hadrosaurus* had been inverted by their describers. The medullary cavity was filled with open cancellous tissue. The species, which was one half larger than the type specimen of *Hadrosaurus Foulkii*, he named *Ornithotarsus immanis*.

OBITUARY.

John William Salter, A.L.S., F.G.S. Born December 15, 1820. Died August 2, 1869.—This eminent Palæontologist, after an education at a private boarding-school, was, in April, 1835, by his own wish, bound apprentice to the well-known James De Carle Sowerby, with whom he hoped to pursue the study of Natural History (especially Entomology) for which he had, from childhood, an ardent love. He has been known to pull his companions (Wm. and J. Sowerby) out of bed on a cold winter's morning to wade through the snow after some insect, the habitat of which he had just heard of; or, at other times, knee-deep in the long hay-grass to a favourite pond after water-insects. About this time (1836-7) he wrote his first paper "On the Habits of Insects," read at the "Camden Literary Society."

With Mr. Sowerby he was engaged in drawing and engraving the plates of "Sowerby's Mineral Conchology," then in progress towards completion; Supplement to "Sowerby's English Botany;" "Loudon's Encyclopædia of Plants;" "Murchison's Silurian System." The figures for these and many other scientific works, engraved by Mr. Salter at this time, being all drawn from the actual specimens, he was, naturally, training his eye to that perfect knowledge of fossil forms which, in later years, rendered him so distinguished and keen a Palæontologist.

In 1842 he visited Cambridge, where he remained for a short time to assist Professor Sedgwick in arranging the fossils of the Woodwardian Museum. It is not uninteresting here to note, that the first and the last independent work of his life was at the Cambridge Museum in connection with Sedgwick, who continued to be to Salter, up to the last, what, indeed, he has been to so many others, a staunch and generous friend.

In that and the three following years he made several short trips into Wales, and did his first field-geology under Sedgwick's teaching, whom he always referred to as "the Master."

In 1846 he married Sally, second daughter of Mr. J. De Carle Sowerby, with whom he had learnt that art of which in the illustrations to so many scientific works he has left testimony showing not only the ability of the master but the aptitude of the pupil.

In the same year, at the age of 26, he entered upon the Geological Survey, and for eight years served as chief assistant to the Palæontologist, Prof. Edward Forbes. Writing to his friend Dr. Grindrod, of Malvern, Salter says,[1] "From 1846, to the time of Forbes's removal to Edinburgh in 1854, I shared with him the arrangement, description, and cataloguing of the public fossil collections of the Survey, took part in the field-work, and in all other duties shared the work with him and had his full approval."

On the retirement of Edward Forbes it was found expedient to separate the Lectureship on Natural History from the office of Palæontologist. Prof. T. H. Huxley was accordingly appointed to the former post (with the title of "Naturalist"), and Mr. Salter to the latter office.

"The duties of Palæontologist to the Survey consisted of Field-duty in connection with the work of the Local Directors and Surveyors; the arrangement of the materials collected, and their naming, comparison, and collocation in the cases; the selection of duplicates; and correspondence with Naturalists and Geologists at home and abroad."[2] Such is the account Mr. Salter gives of the work he was called upon to fulfil.

In consequence of the increasing extent of the labours of the Geological Surveyors, the examination of the Irish fossils was, in 1856, handed over to Mr. W. Hellier Baily, and, in the following year Mr. Robert Etheridge, having been appointed to the Geological Survey, took charge of the fossils of the Secondary and Tertiary formations of Britain, thus leaving Mr. Salter free to devote his whole energies to his favourite work—the fossils of the palæozoic formations.

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[1] The letter we refer to is dated "Leicester House, Malvern. Nov. 14, 1868," and is addressed to Dr. Grindrod and W. Mathews, Esq., M.A., F.G.S., and appears to have been intended for publication, with a view to soliciting a pension from Government, which, owing to his retiring at the end of 17 years' service (in 1863) he was not entitled to claim.—Edit.

[2] Extract from the same letter.

During his period of office Mr. Salter prepared three Decades, with 10 plates each (8vo. size), on the Trilobites in the collection at Jermyn Street, and, in conjunction with Prof. Huxley, a Monograph on the genus *Pterygotus*, illustrated with sixteen folio plates. He also completed a Decade on the *Echini*, commenced by Prof. Forbes; and supplied a part of the palæontology to Prof. Phillip's Memoir on Malvern.

The Palæontological portion of Prof. Ramsay's Memoir on North Wales was also written by Mr. Salter.

One result of the combination of the "Geological Survey of the United Kingdom" with the "Museum of Practical Geology" and the "Royal School of Mines," has been not only to require from the officer holding the position of Palæontologist a large amount of routine work in examining and naming specimens and preparing lists of fossils of most prodigious length in connexion with the Survey, but the duties of a Curator in arranging and naming the fossils exhibited in the Museum, and, added to all this, a series of demonstrations have to be given annually to the pupils of the School of Mines, on fossils characteristic of the various strata, with their range and distribution in time and space.

More than thirty papers by Mr. Salter, on various geological topics, are to be found in the Journal of the Geological Society; he also wrote in the "Annals and Magazine of Natural History," the GEOLOGICAL MAGAZINE, &c.

Four parts of a Memoir on British Trilobites, illustrated by thirty 4to. plates, and 216 pages of text, have been published by the Palæontographical Society.

In Murchison's "Siluria," and Lyell's Manual, Mr. Salter's services, with both pen or pencil, are apparent and acknowledged. Mr. Salter has also contributed to Sedgwick's Memoirs, 1844 to 1847; Sharpe's Memoirs (Geol. Proceedings); Reports of the British Association, 1844–1868 (Sections).

In the published account of the Arctic voyages of Beechey, Ommaney, and Penny, the description and correlation of the fossils was made by him. Mr. Salter has described fossils from the Himalayas, Australia, China, South Africa, Canada, Oregon, etc., etc.

A list of sixty separate papers by Mr. Salter is given in Bigsby's *Thesaurus Siluricus*, in the preparation of which he was also engaged.

He projected, and, conjointly with Mr. Henry Woodward, prepared a Tabular view of British Fossil Crustacea, showing their range in time, which was engraved and published by Mr. J. W. Lowry, in 1865, and, but for the great expense attending the engraving, several other groups were also intended to be tabulated.

In 1865, Mr. Salter received the "Wollaston Donation Fund" from the Geological Society, in recognition of his valuable services to Palæontology, and especially for his Monograph on Trilobites, then in course of publication by the Palæontographical Society.

After his retirement from the office of Palæontologist to the Geological Survey in 1863, he was engaged at various times in arranging and naming the Palæozoic Invertebrata of the Manchester, Leicester, Leeds, Worcester, Malvern, Taunton, and Cambridge Museum collections; he also executed numerous plates and woodcuts. A catalogue (illustrated by himself) of the Cambrian and Silurian fossils in the Woodwardian Museum was one of the last tasks which he undertook, and which remains uncompleted, as does his Monograph on the Trilobites.

It is difficult to say what combination of official conditions could have been found better suited to him than those in which he was placed. He often pictured the happiness of a post in the British Museum; but it is doubtful, had he realized his hope, whether his health would have improved. Those who knew him well, will remember how cheerful and light-hearted he was at times; he was, in many ways, remarkably like a child, fond of boyish athletic sports, a lover of Nature, fond of wild-flowers, and domestic pet animals, which he encouraged his children to keep. Anon he would be fretful and irritable, often without any reasonable cause, proving that the chronic ill-health of which he complained was certainly mental.

His staunch friends, Murchison and Sedgwick, helped him right manfully throughout, and he had many friends in the West of England and in Scotland, who gladly welcomed him to their homes, and cordially sympathized with him. But though he spoke cheerfully and hopefully after resigning his post at Jermyn-street, we have his written testimony that he regretted the step he had taken.

No one, however, who will fairly weigh the amount of valuable work done by Mr. Salter, and the large contributions he has made to our knowledge of the palæozoic rocks and the early life-forms which they contain, will deny that a man of such ability deserved some recognition in the way of pension from Government; and it is sincerely to be hoped that Mrs. Salter, with her seven children, may at least be granted some small share of the Royal bounty, as some acknowledgment of the services rendered to science by her husband.

Mr. Salter is buried in Highgate Cemetery, the resting-place of several of his fellow-workers in science.

JAMES HUNT, Ph.D., F.S.A., F.R.S.L., etc.—We regret to have to record the death, on the 29th August, at the early age of thirty-six, of James Hunt, Ph.D., F.S.A., F.R.S.L., founder of the Anthropological Society of London, and its first President, an office he held during five years. Soon after the foundation of the Society in 1863, the deceased, with that spirit of enterprise which distinguished him, established the *Anthropological Review*, of which he was proprietor and Editor from its commencement to the current number. Whatever may be the future of Anthropology in England, the name of James Hunt will long be remembered as one of the most active and disinterested workers in that branch of science of which he was passionately fond, and in the pursuit of which he died.

ERRATUM.—In the Obituary of Mr. J. BEETE JUKES last month, p. 431, the name of Mr. A. SELWYN, his associate in the Survey of North Wales, was accidentally omitted.—EDIT.

THE
GEOLOGICAL MAGAZINE.

No. LXV.—NOVEMBER, 1869.

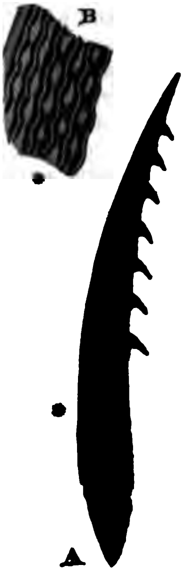
ORIGINAL ARTICLES.

I.—NOTES ON TWO ICHTHYODORULITES HITHERTO UNDESCRIBED.

By Professor OWEN, F.R.S., etc.

IN a recent inspection of the grand collection of Fossil Fishes in the Museum of the Earl of Enniskillen at Florence Court, his lordship called my attention more particularly to two Ichthyodorulites, which he believed to be new.

I was unable to refer them to any known or named species, and, in compliance with my friend's desire, I here record a brief notice of their distinctive, and, I believe, specific characters.



Lepracanthus Colei, Owen. Coal-measures, Ruabon, N. Wales.

The first specimen (see Woodcut, Fig. A.), was discovered and worked out of the coal-shale of Ruabon, North Wales, by Lord Enniskillen himself. It belongs to the rare genus, called *Lepracanthus* by his friend and fellow labourer in Palichthyology, Sir Philip Egerton,[1] whose intention I fulfil in dedicating the species to his lordship, under the name *Lepracanthus Colei*.

The generic name of this fossil fish-spine refers to the form and serial arrangement of the minute risings or short ridges on the enamelled part, which give it a resemblance to the scaled covering of a ganoid fish.

The more obvious arrangement of the minute scale-like risings is longitudinal, and nine rows may be counted on each side of the basal half of the ganoin, but the risings are not parallel transversely in the several rows; they project so as to lie in oblique series across the side of the spine, which adds to the resemblance above noted (see Fig. B, magnified portion). The spine is gently curved, moderately compressed, with the back or convex border rounded; the thinner concave border is armed by relatively large recurved pointed denticles, sub-compressed and strengthened by an almost ridge-like swelling along the middle of each side. These denticles are few in number compared with most similarly barbed fossil fish-spines; four project from about one third of the length of the body of the spine, and not more than seven are traceable in the present specimen. The ganoin, which enamels that body, terminates as usual below in an oblique line descending from the dentate border to the thick convex border or fore part of the spine. The implanted base is also, as usual, smooth and finely striated lengthwise.

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[1] See "Agassiz, Histoire des Poissons Fossiles." 4to. tom. iii. (1842).

The length of the spine, as here preserved, is 2 inches; but adding the wanting point according to the indications of the rate of contraction, and from the impression in the counterpart leaf of coal-shale, the entire length would be 2½ inches; the greatest breadth is three lines; the thickness at that part is ⅜ line.

The soft plastic state of the carbonaceous oose in which this weapon, with probably the fish that bore it, sunk, and ultimately settled, is shown by the exquisitely beautiful impression of the ornamentation of the glittering blade which the hardened coal now retains.

Fig. A, side view of *Lepracanthus Colei*, nat. size. B, magnified view of part of the ganoin.

Hybodus complanatus, Ow.—This spine rests in a block of stone, from the Iguanodon-quarry of Mr. Bensted, at Maidstone, of the Neocomian or Greensand period, the latest, I believe, in which any evidence of the genus *Hybodus* has been detected. The sides are flatter, and join the thick hinder border at a less open angle than in most other Hybodont spines.

The sides are longitudinally ridged, but with less regularity and with more variety in the size of the ridges, than in any other *Hybodi*. At the summit they are fine and close set, but they slightly increase in thickness toward the front margin; they recede from each other as the spine expands and descends: the finer ridges at the hinder half of the side continue close-set along the upper half of the spine, and also for one third of the breadth of the side next the inner concave border. The thicker ridges at the lower half of the enamelled body, are reduced to three or four in number, separated by a smooth tract, along the middle third of the side, from the finer ridges: the coarser ridges near the front border become reduced to two along the basal fourth of the enamelled body, with a wide smooth or unridged interval between them and the finer ridges. The anterior border is narrow, but obtuse. Along the middle of the broad flattened hinder border, a series of short strong recurved denticles arms the very low or open angle at which the halves of the hinder border meet; there are about thirty denticles along this angle: they are thick, triangular, two lines across the base, nearly three lines in length, pointed. The enamelled body of this spine is slightly recurved.

From *Hybodus reticulatus* (and from *Hybodus curtus*, which is the second shorter spine of *H. reticulatus*),[1] the present species differs in

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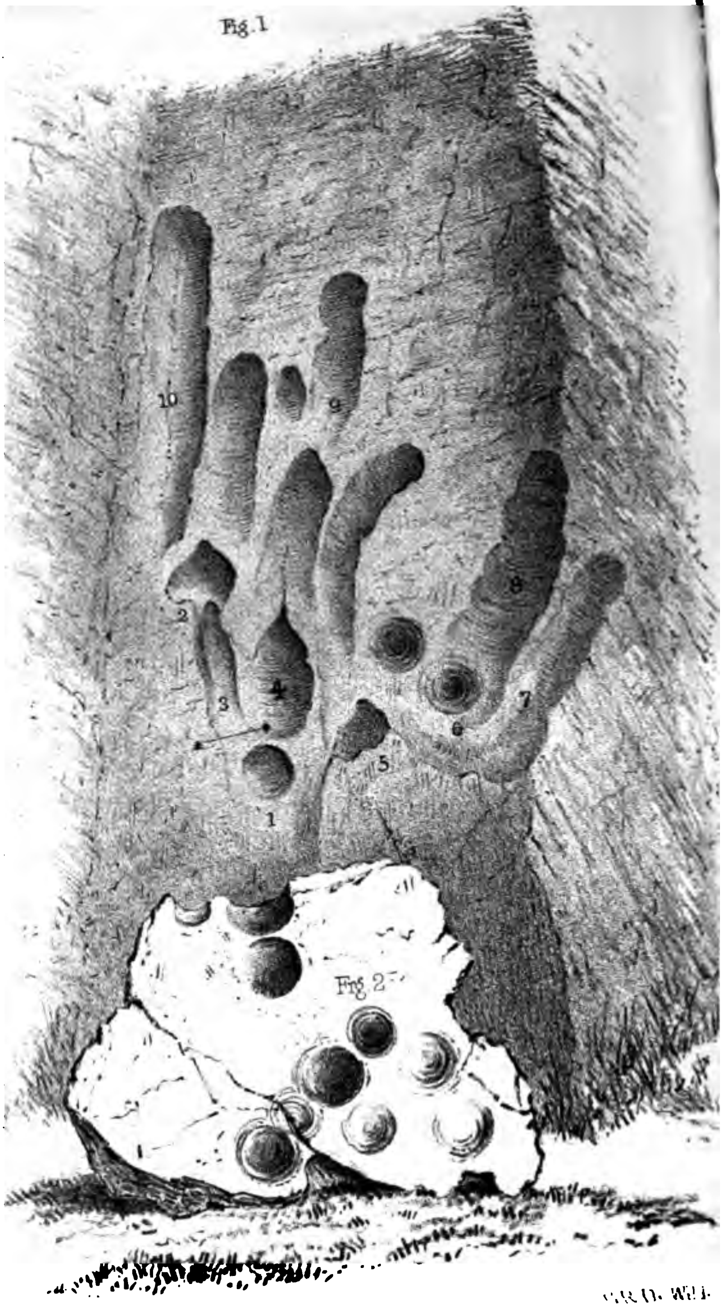
[1] This fact is shown in the rare specimen with teeth, integument, and both spines of *Hybodus reticulatus* in the Museum at Florence Court, where Agassiz recognised his *Hybodus curtus* in the second smaller spine, on his last visit to Ireland.

g 1869.



T. G. Bonney delt

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Burrows of Mollusca in Carboniferous Limestone
Great Ormes Head

the non-continuance of the numerous ridges down the sides. *Hybodus formosus* differs in the larger ridges, with wider intervals, and a more regular disposition over the sides of the spine. In both *H. reticulatus* and *H. formosus*, the halves of the hinder border meet at a less open angle, and the median dentated ridge is more prominent; consequently the hind border meets the lateral surface at a more open angle than in *H. complanatus*.

From the known species of *Acrodus*, the present specimen differs in the pattern of the ridging of the sides: the ridges in *Acrodus* are fine, but regularly longitudinal, and in some specimens almost obsolete. The sides of the enamelled body of the spine are less flat, more convex, in *Acrodus*, and the spine is thicker in proportion to the breadth in *Acrodus* than in *Hybodus*.

The length of the present spine of *H. complanatus*, is 1 foot 4 inches; the breadth is 1 inch 9 lines; the thickness posteriorly is nearly 1 inch.

The proportions of the enamelled and unenamelled surfaces of the spine, the obliquity of the terminal basal line of the ganoin, and the excavation of the smooth implanted basal part or root, accord with the usual Hybodont type of Ichthyodorulite.

II.—On the Supposed Occurrence of Pholas Burrows in the Upper Parts of the Great and Little Ormesheads.

By T. G. Bonney, M.A., F.G.S.

(PLATE XVII.)

In a paper entitled "On Traces of Glacial Action near Llandudno," printed in the Geological Magazine, Vol. IV. p. 289, I described certain indications of glacial action (as they appeared to me) upon the two masses of Carboniferous Limestone, well known to visitors at Llandudno under the name of the Great and Little Ormesheads. The principal conclusion at which I arrived was that, "after the limestone hills of the district had acquired their leading forms by upheaval and marine denudation, the whole district was depressed. The summits of the low rocky islets thus formed became capped with ice-fields, which in places descended in glaciers into the sea. At times, very probably, they were united to the mainland by pack or coast ice." I then supposed that, after some minor changes, "the whole was gradually upheaved above the sea, probably—at any rate, in the case of the Great Ormeshead—not quite uniformly."

This conclusion was opposed by Mr. R. D. Darbishire in a paper read before the Literary and Philosophical Society of Manchester, and published in their Memoirs (ser. 3, vol. iv.), a copy of which he very kindly sent to me. In this, after mentioning sundry indications of marine action, he describes certain burrows which he has discovered on various parts of the above hills, and considers to have been formed by a species of *Pholas*, probably *P. crispata*. He comes, therefore, to the following conclusion: "In the preservation of these burrows, in loose beach stones, and in the edges of the tables of out-cropping strata, and in the level sea-stripped scars, I submit that we have final and irrefragable proof that the surface of these anciently submarine hills had not been touched by the iceberg or glacier for some time before, nor at any time since, they respectively emerged from the waves."

I have recently had an opportunity of examining the neighbourhood of Llandudno, with the aid of Mr. Darbishire's very interesting and valuable paper, and will endeavour to state why on this point I see no reason for altering my conclusion. If I rightly understand him, we are agreed that the district shows signs of both marine denudation and glacial action; the debate, therefore, is narrowed to this one point, whether or not these hills have been capped by ice since they were covered by the sea. Mr. Darbishire argues for the negative answer from the presence of (1) sea-beach and beach marks; (2), Pholas burrows.

(1). Among these he enumerates certain large blocks lying on the upper plateau of the Great Ormeshead, "the remains of the play or rage of the waves about the head of the new-born island, and as such emphatically a raised beach of the grandest kind," and several nearly horizontal surfaces of limestone in the same neighbourhood, "cut and furrowed, and worn in fissures, potholes and other forms, very similar to those of the like beds in like-positions in the intertidal spaces below." These blocks I had described, figuring one of the largest (Plate XII. Vol. IV. p. 289) as most probably *blocs perchées*. That this is a gigantic stranded boulder is placed beyond dispute by a very brief examination of the locality. Its base is flat, and rests upon three slight projections in the rough shelving scar of limestone, upon which it lies. The only question is by what agency it has been conveyed to its present position. This may have been done:

(*a*). By the force of the waves, as suggested by Mr. Darbishire. No doubt the position of this, and the numerous other similarly situated blocks, might be accounted for in this way; but in that case, I think, we might fairly expect to see a more beach-like arrangement of the boulders, a larger quantity of rounded pebbles, and (as the elevation of the Head can hardly be more recent than the deposition of the lowland 'till' with its numerous boulders of trap and foreign rocks—often ice-scratched) a considerable sprinkling of boulders from the neighbourhood of Conway. Mr. Darbishire himself acknowledges that he has "not found anywhere at the higher level one block of any other rock than Mountain Limestone." The weathering of the limestone scars in the neighbourhood, which he brings forward, with some reserve, as a proof of marine denudation, does not differ from what may be seen on most horizontal surfaces of limestone, and may be produced by the action of the atmosphere and of freshwater impregnated with carbonic acid gas. I am familiar with similar markings in many limestone districts far away from the sea, among others in parts of the higher Alps.[1]

[1] During my examination of the large boulder mentioned above, I was led, in a search for 'Pholas' burrows, to look narrowly into a crack about an inch and a

(*b*). By being dropped from floating or stranded bergs. The objection to this is the difficulty of understanding, without assuming a considerable alteration of level, whence these blocks could have been derived, and the evidence (as it appears to me) in the contour of parts of the Great, and more especially of the Little Ormeshead, of glacial subsequent to marine action.

(*c*). By being moved to their present position by land ice. The difficulty in this explanation is that the only broken crest of rock now visible (to the N.W.), from which such a boulder is likely to have been derived, is but little higher than it. This crest, however, is higher than the base of the boulder, and the rock to the S. is still more elevated, although it is now a bare scar. Possibly some of these blocks may represent a former extension of the 'reef' over this now denuded portion. There is also much higher ground to the S.E. Mr. Darbishire appears to feel a difficulty in regarding a block as 'perched,' unless it has travelled from a distance, in saying, "They are uniformly of a stone apparently identical with the beds in their immediate neighbourhood, and may often be connected with a neighbouring reef of rock, both by the character of the stone, and the style of wearing. A few may be found actually in situ, as isolated pillars or tables," etc. (p. 14.) I never supposed that they had travelled more than a few hundred yards, at the most; and the distance a block is conveyed by a glacier, will be little, or great, according to the size and form of the ice-stream; nor did I intend to imply that I considered the Ormeshead glaciers to be large. All the indications of an *extensive* glacier system are wanting. Therefore, notwithstanding some difficulties, I still adhere to my opinion that many of these scattered masses of limestone rock are true *blocs perchées*.

(2). If, however, Mr. Darbishire is right in attributing the peculiar pits and depressions in the limestone rock to the excavating action of some species of *Pholas*, the question is pretty well settled; for although under certain circumstances the sea (as may be observed on many parts of the west coast of Norway) has surprisingly little effect in obliterating the traces of glacial action, it is improbable, to say the least, that any would have survived in a rock so liable to denudation as carboniferous limestone, and in a position so exposed as the Ormesheads. But are these pits *Pholas* burrows?

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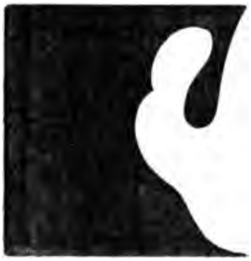
quarter wide, indicated in the middle of the side towards the spectator, in the plate. At a depth of about three inches it appeared to be choked with angular fragments of limestone, among which could be seen a shell, which, when uncovered a little, proved to be *Buccinum undatum*, wedged in with its spire downwards. As it had a very ancient appearance, I supposed that this would make for the marine theory; but a little poking at it with a chisel showed that the fragment in contact with it above was bone, probably of a sheep. Beneath the *Buccinum*, was a shell of *Helix aspersa*. Further examination of the crack showed that it extended to the upper part of the stone, and widened in that direction, so as to be at last three or four inches across. It was filled with limestone fragments to within a foot or so of the top; on removing the topmost of these, I found a fresh bone (part of the clavicle (?) of a lamb). I suspect, therefore, that the *Buccinum*, with the bones, were dropped down the crack by a raven or a gull. I was confirmed in this view by finding that I could not succeed in extracting them from the crack by the lateral aperture.

I have long had suspicions that they are not; and the very fact of their discovery some 1,400 feet above the sea on the hills of Derbyshire,[1] appeared, by proving too much, to do worse than prove nothing. Is it not in the highest degree improbable that such burrows, so easily weathered, should have survived the atmospheric waste of so many centuries? What is there to show that these hills of central England have been submerged since the period when the valleys of Wales and the Lake-districts were filled with glaciers; and, without very strong corroborative evidence, are we justified in assuming such an inequality of upheaval as would be required in this case? If, however, the Pholas burrows belong to an earlier epoch, say to that of the drift shells on Moel Tryfaen, is it likely that they would have escaped the action of ice and weather during the subsequent glacial period? But to return to the supposed Pholas burrows at Llandudno. Most of the limestone of which the neighbouring hills are composed appears to have a tendency to weather in generally oval or circular pits; so much so, that not unfrequently a face of rock appears to have suffered from a kind of gigantic small-pox. Still, besides these and other cavities, often curiously regular, which may be set down to atmospheric action in one form or another, there are a considerable number occurring at various elevations above the sea—roughly speaking, almost all over the Great Ormeshead—which cannot be thus accounted for. Of these I select two groups for especial description.

The first is in a block of limestone which projects from the steep turfy slope on the northern face of the Great Ormeshead, a few yards below the pathway which surrounds the mountain. It is in the line of a slight glen or depression by which a narrow track leads to the upper plateaux, some three or four hundred yards to the east of St. Tuduo's Church. The burrows are clustered about a natural subangular step on the north-western face of the block, the lowest being about a foot from the turf. The annexed sketch (Plate XVII., Fig. 1) will show their general character better than any description. The following are some notes on the burrows numbered in the figure:—(1). About an inch in width, and two in depth, it curves gently upwards, having a small aperture in the side at the point.° (2). Does not extend any further into the stone. (3). Extends, curving gently upwards, for about 1½ inches; this contained a small specimen of a banded Helix. (4). Extends nearly four inches upwards into the stone, presenting in section through its axis, roughly, the form indicated in the accompanying figure. (5). Descends slightly. (6). About one inch deep, and at right angles to the channel in which it is placed. (7). A curved channel, about one inch wide, not extending up into the stone. (8). A curved channel, rather irregular in section, perhaps a natural depression. (9). A curved channel,



Section of Burrow, No. 4.

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[1] See note and references at the end of Mr. Darbishire's paper.

apparently, from the form of the end, a burrow, but much weathered. (10). A channel of dubious origin. The other unnumbered burrows extended but a very slight distance into the stone, and presented no special features. I did not think it worth while to make very precise measurements of the burrows, for at best they could only be approximate, but most of them were a little more than an inch in diameter.

The second group of burrows was on a somewhat similar block on the eastern face of the Great Ormeshead, about fifty or sixty yards from the second gate on the pathway round the mountain. My attention was attracted by some fine burrows on the southern side of the stone, a few inches below the top, and above a roughly horizontal fissure rather more than an inch in greatest width. At right angles to this fissure was a smaller one. To the right of this were two burrows, one small, the other about 2½ inches deep, and more than an inch in greatest width; and, on examining them, I found a third immediately behind the latter. To the left was a pair of burrows, one of which was partly concealed in the rock; in this, and in the third of the other group, fine specimens of *Helix aspersa* were snugly nestled. Wishing for a specimen of these burrows, and seeing a fair chance of obtaining one in tolerable condition from this boulder, I proceeded to break away some of the stone, and then found that the horizontal fissure extended some inches deep into the stone, narrowing very gradually. On thrusting my fingers into it, I detected other burrows also tenanted by living *Helices*, and saw several empty shells in the fissure. I then broke away the stone as well as I could, a task of much difficulty with the means at my command. Thus, after putting the fragments together, I obtained a portion of the roof of the fissure, in which, besides those already mentioned, are four distinct burrows, and two circular depressions. Two of these burrows were tenanted by living specimens of *H. aspersa*. For their position and arrangement, see Plate XVII., Fig. 2. Now, these four inner burrows are perfectly smooth, fresh, unweathered, and are stained with the excretions of the snails; the deepest is about an inch, the shallowest half-an-inch. They are all of them completely protected from the weather; the most remote being nearly four inches from the centre of the large burrow seen from without. In form they coincide with those described by Mr. Darbishire in the following paragraph: "All the holes that I have seen occur in surfaces which have obviously suffered some superficial waste. Hence the smaller holes, which usually crowded the surface of a burrowed stone off a recent beach, have generally disappeared, *and the fossil-holes which remain are the ends of the larger perforations.*"

Besides these, I examined a large number of other groups on the Great Ormeshead, and some on the Little Ormeshead, with the following results. (1). They are clearly the result of the action, mechanical, chemical, or both, of some living agent. Many of them are in positions where rain or wind cannot reach them, run almost vertically up into the rock, and are practically impervious to water at the highest point. (2). They are rarest on surfaces much exposed to prevailing winds, or where the rock approaches to a grit. (3). They usually occur on boulders, or projecting rocks, at no great distance from the surface of the soil; in not a few cases the turf had actually grown into them. (4). The axis of the burrow usually is not at right angles to the surface of the rock; often is only inclined at a slight angle to it, so that the burrow commences as a channel (if this be not a natural depression utilised), and sinks gradually into the rock. Frequently it is driven into some slight prominence, as though the burrowing animal had first sheltered itself under the lee of this, and then gradually worked its way deeper into the rock. (5). The burrows are very frequently curved. Sometimes the tangents to the axis at the two extremities, if produced to meet, would include an angle not very much greater than 90°. (6). *Helices*, especially *H. aspersa*, are generally abundant in the neighbourhood of these burrows; empty shells are common in them, and in the freshest, smoothest, and least weathered of them, I always found a living *Helix*. (7). The constriction in the upper part of the burrow, characteristic of perfect Pholas excavations, is generally wanting, and though the burrow sometimes contracts towards the mouth, this is often not quite regular in form; so that a *Helix* which would exactly fit the end would be able to quit the burrow. At least, I believe this to have been the case with all that I examined. The ends, also, of the burrows are, I think, generally rather flatter than is usual with Pholas holes.

From the above considerations, and especially from the position of the cavities in the second example described above, the conclusion is, I think, irresistible, that these are not the weathered burrows of departed *Pholades*, but have been and are being hollowed out by *Helices*, the principal, if not the only agent being *H. aspersa*.

I may, perhaps, in conclusion, be allowed to advert to two other points of my paper, which have been criticized by Mr. Darbishire. (1). The shells found about the sand pit at Gwyfyd farm. (2). The mussel beds exposed in the sand cliffs in Conway Bay; both of which he considers to have been brought to their present sites by the hand of man.

The former deposit being now nearly exhausted, I could obtain no fresh evidence as to its age. When writing, I did not overlook the possibility, strengthened by proximity to the fortress on Pen-y-Dinas, of this being a kitchen-midden; but the condition of the shells, so different from those in the middens on the S.W. face of the mountain, their comparative rarity, the way in which they were mixed up in the red clay, and the "lie" of the neighbourhood, made me then, as now, think it possible that they had been deposited under water. The latter deposits I have re-examined. On the former occasion I was quite aware of the existence of mussel fisheries in that neighbourhood, and at first attributed these beds to them, but the number of instances in which (in one bed especially) I found both valves in contact, certain indications of a raised beach, and the apparent antiquity of the deposit, inclined me to the opinion that they were not refuse heaps. This conclusion I now think to have been erroneous. I detected lately in one of the lowest seams in the second set of deposits N. of Tremlyd Point, many bits of carbonized wood, with fragments of bone, pebbles, and stones, some of which appeared to have been burnt, together with the right metacarpus of a sheep, perfect but carious. Above this deposit was between eight and nine feet of sand, with some thin seams of mussel shells, about 3½ ft. up, capped by a seam nearly a foot thick, just under the sandy surface soil. A little to the north, and still lower down in the cliff, was a thin dark carbonaceous band, in which I found two teeth, very decayed, of a sheep. This, and the first seam also, contained rotten fragments of *Littorina*, *Purpura*, *Buccinum* (?), *Cardium*, *Tapes* (?). Still further to the north we have the following section. (1). Sandy soil, with mussel shells, 9 inches. (2). Sand, with fragments of mussel shells, 4½-ft. (3). Mussels, with carbonized wood, ½-ft. (4). Sand, 1-ft. (5). Mussel shells, 2-ft. (6). Sand, and sandy talus, about 3 feet. (7). Shore a little above high-water mark. Nevertheless, though I have to thank Mr. Darbishire for correcting my error, I yet doubt whether all these deposits "must be set down as appertaining to the most recent human period." That, however, is a point of minor importance.

P.S.—The above paper was written immediately after making the observations recorded therein. At that time I concluded, from the silence of those who had written or spoken on the subject, whether before the Literary Society at Manchester or the Geological Society of London,[1] that no literature existed on the subject. Since my return to Cambridge, in conversation with various friends, I have been directed to sources from which I find myself not alone in the opinion expressed above. See especially the abstract of a paper "On the Agency of Land Snails in corroding and making deep Excavations in compact Limestone Rocks," by Dr. Buckland, in the Proceedings of the Geological Society of London, Vol. iii., p. 430; and a valuable memoir, "Observations sur les Hélices Saxicaves du Boulonnais," by M. Bouchard-Chantereaux.[2] The author of the latter discusses at considerable length the mode of excavation, and attributes it to the action of an acid secreted by the snail's foot. His observations on the form and arrangement of the burrows correspond very closely with my own, and his excellent lithographs of two groups might almost have been copied from some of those near Llandudno.

III.—On the Surface-Geology of the Lake-District.

By C. E. De Rance, of the Geological Survey of England and Wales.

THE following notes were made during a few days' leave of absence, spent chiefly on the Green-slate area of the Lake-district, the beds of which have an east-north-east and west-south-west direction of strike, extending across the country in a belt about fourteen miles in width, resting on the Skiddaw Slates, and passing under the various divisions of the Coniston series. The characteristic feature of this tract of country is the uniformity in direction of all the gorges, or depressions, in which the lakes occur. The initiative of their direction (as pointed out by Dr. Nicholson)[1] appears to have been given by a system of north and south faults : thus Windermere, Rydal Water, Grasmere, and Thirlmere may be said to lie in one line of depression. Between the two last-mentioned lakes the pass of Dunmail Raise forms a col between two valleys. In the bottom of the valley, between the pass and Grasmere, there are immense mounds of moraine matter, the pebbles are all angular and strictly local. Steel Fell and Seat Sandal form two cliffs on either side, that on the western being much the steeper; the summit of Helm Crag, being much weathered, forming the well-known "couchant lion with a lamb under its nose," of the guide books. Following up the ice marks of Easdale Valley into that of Raise Beck, there seems little doubt that the two glaciers occupying these valleys united between Silver How and Nab Scar, and thence bore down upon Loughrigg Fell, which stopped its forward progress in a direct line, deflecting it into what is now Rydal Water. The lake Grasmere is excavated in a rock-basin, and one can easily understand its excavation being due to the immense pressure of the ice infringing on Loughrigg Fell. A similar state of things took place at the foot of Rydal Water; the rocks here are moutonnèed and glaciated upwards.

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[1] Quarterly Journal, Vol. xxv. Proceedings, p. 280.

[2] Annales des Sciences Naturelles. 4me Ser., Zoologie. Tome xvi., p. 197.

Moutonnèed rocks occur wherever the gorges are narrow and contracted, or wherever a mass of rock, opposite the entrance to a valley, formed a bar to the further progress of a glacier. The glaciated rocks above Skelwith Force being an example of the first; those at the entrance to Grisdale, above Patterdale Hall, of the second.

The feature which strikes the eye of a geologist, on viewing the country from the top of Helvellyn, is not the "sea of mountains" of the guide books, but the flatness of the tops of the hills; the valleys and gorges appearing mere gashes in the upland plain. This plain (which may possibly be part of that old plain of marine denudation which has been described by Professor Ramsay, in his "Geology of North Wales"), varies but little in elevation; the watershed of the lake country, as pointed out by Mr. Bolton, being a complete circle. Within this circle all the streams flow north, and fall into the rivers Derwent and Cocker, which unite at Cockermouth, and thus drain nearly the whole of the Lake-district. Some of the most remarkable passes of the district are situated on the southern edge of this circle, as Kirkstone Pass and the Pass of Dunmail Raise. It would thus appear, before rain began to fall, and rivers to flow, over this tract, in pre-glacial times, that there was a circular tract of high flat land in the centre of the district, surrounded by sloping ground dipping outwards in every direction. This circular plain (the top of a truncated cone) being no doubt the result of a pause in the subsidence during which the sea denuded the rest of the country into a gently inclined plane.

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[1] Geology of Cumberland, p. 18.

Mr. Mackintosh, in an article on the Lake-district in the GEOLOGICAL MAGAZINE for 1865, comments on the fact, that "we continually meet with a precipitous *escarpment* running along one side of a mountain-range, the other side of which is a gradual slope;" and, further, that "the steep escarpments generally face the east, south-east, or north-east, apparently showing that the indenting and undermining current must have assailed the ancient Cumbrian Archipelago from the east." His facts are undoubted, but I regret I cannot agree with the inference. For if the sea formed the indented voes of the eastern slope of Helvellyn, acting from the east, it could not have also formed the precipitous slope of the *western* side of the narrow Thirlmere valley, also acting from the east; for as the valley runs in a north and south direction at the foot of Helvellyn, it follows that the sea must have entirely denuded away the Helvellyn range, before it could have been exposed to the eastern breakers. It seems to me rather that the western sides of the gorges, or eastern sides of the hills, are steeper because they are most exposed to frosts and consequently to landslips than the opposite sides. My friend, Mr. Bolton, of Ulverstone, thus describes the effects of a winter's frost on the disintegration of the rocks of the lake district:[1]—"At Dow Crags sometimes may be seen a spectacle of no common interest; the immense cliffs for a considerable distance are perpendicular, and in some places overhang the base, containing fissures and joints which admit moisture. . . . A hard frost in winter converts all this into ice, which, by its natural expansion, forces off from the parent rock large masses of stone, to bound and crash along the steep descent at the foot of the cliffs, ... some large blocks even entering Goat's Water before their progress is arrested, the border of that small lake being covered with their debris . . . several single stones . . . . weighing about three or four tons each."

The western sides of the valleys are more subject to landslips than the eastern, not only because they are more subject to the frost influence of easterly winds, but because the normal dip of the Green-slate being south-easterly, the rocks of the western slopes have an upward dip, causing the beds to have a tendency to slide along the dip planes into the valley beneath, while the inward dip of the eastern slopes defy the effect of frost to disintegrate their mass. They do not, however, entirely escape; for though less ruthlessly, and less suddenly destroyed, the gradual wear of western storms of wind and rain, round the step-like form, first impressed by the running brook, and finished by the glacier, into a gradual slope, or rather a parabolic curve.

At page 304 of his article, "on the Lake-district,"[2] Mr. Mackintosh mentions the *eastern* side of Helvellyn, as a "sea cliff," which he accurately describes as being, "not only the most precipitous, but indented with voes separated by *edges*, one of the voes terminating in Red Tarn Cwm." I have not the 6-inch ordnance maps of this district, but from a rough observation I made, when descending the precipitous slope described by Mr. Mackintosh, believe the base is about 860 feet below the apex of Helvellyn, dipping at an angle of from 40° to 60°; on the Catchedecam side the angle is rather less. on Striding Edge rather more. From the bottom of the precipice to Red Tarn is a gradual slope of perhaps 50 feet. Through the centre of this slope, flows Red Tarn Beck, the first commencement of which is found in a small pond of running water immediately below the precipice, fed by a number of springs, issuing from the base of the cliff. The water, notwithstanding the great heat of the weather at the time of my visit (August), was intensely cold. From the dryness of the season, the lake Red Tarn was empty. and I therefore had an opportunity of examining its bottom. The banks consist of angular fragments, derived from the mountain above. none seemed to have experienced ice or glacier action, and most certainly there was no sign of the sea, neither a rounded pebble, or a single foreign fragment. The bottom of the Tarn was composed of fine sand brought by the springs out of the mountain; the banks of fragments, torn off its slopes by frosts and landslips. The sub-aërial deposit in which this lake occurs, appears to have choked up the bottom of the gorge under the mountain to a considerable depth, but following Red Tarn Beck, down the valley towards Ulleswater, the beck cuts down to rock, which is here and there glaciated. If the sea formed the two voes on either side of Striding edge, it is difficult to understand why it did not destroy the edge itself, especially as we know that the sea destroys headlands at the same and even "quicker rates than it works back lowlands." Though I agree with Mr. Mackintosh, "that, in those river gulleys which graduate upwards into larger valleys we may often discover a sufficient distinction between their respective contours to justify our referring the one to fluviatile, and the other to marine denudation" (p. 303). as applied to some districts, yet I think such hollows of undulation in the original surface of marine denudation, in the lake district, are of extreme shallowness, and play altogether a secondary and unimportant part in the physical features of the country. Nor does it appear that the higher portion of this mountainous district was ever beneath the Glacial sea. From the shortness of the time I spent in the Lake-district, I was not able to make out the height to which it reached, but the rocks did not appear to be glaciated above a level of about 1,700 feet above the sea, the glaciation down to about 400 feet above sea level appearing to have been caused rather by land ice than by the grounding of ice-bergs. In the low country of Furness, the same sequence of upper and lower Boulder-clays, divided by a middle sand and gravel, occurs as was described by Mr. Hull, F.R.S., in 1863, as occurring in the Manchester district;[1] which classification has been adopted by Mr.

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[1] "Geological Fragments," p. 46, 'Dow,' or 'Doe,' crags are a little west of Conistone Old Man.—C. E. R.

[2] GEOL. MAG., Vol. II.

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[1] Additional Observations on the Drift Deposits, etc. Mem. Lit. Phil. Society, vol. ii., 3rd series. Geol. Sur. Mem., on Qr. Sh., 88, S.W.

Mackintosh in his paper on the "North-west Lancashire Drifts," read before the Geological Society on June 23rd of this year.

In the Manchester district, described by Mr. Hull, the upper and lower clays are identical in character; they are both of a reddish colour, contain rounded and sub-angular pebbles and boulders, which appear to have been thrown down from icebergs in a Glacial sea, rather than by an ice sheet. The lower Boulder-clay is stated by Mr. Hull never to make its appearance in the hill country, and the Middle Drift, which rests on the denuded surface of the lower Till, in the low country, is found resting on the bare rock in the upland valleys of south-east Lancashire, and the bordering parts of Cheshire.[1] In one locality near Macclesfield, in an escarpment half-a-mile east of the Little Dog Inn, on the Buxton-road, Mr. Prestwich, F.R.S., discovered marine shells in Middle Drift, at an elevation of between 1,100 and 1,200 feet above the level of the sea,[2] which nearly corresponds in elevation with the bed with marine shells on Moel Tryfaen, described by the late Mr. Trimmer. As these are the highest elevations in which marine shells have been found, and as Mr. Hull, in his paper on the Manchester Drift, states, as Sir H. De la Beche had done long before, that no erratic ascend the hills of that district above an elevation of 1,800 feet, and that "not a trace of a foreign rock occurs on the table-land of the Peak, which is about 2,000 feet high," it would appear that the fact of the absence of all traces of marine action, during the Glacial and Post-glacial periods, above an elevation of 1,700 feet in the Lake-district, is in accordance with what has already been observed in East Lancashire, in Derbyshire, Cheshire, and North Wales, and that there is little or no proof that the north-west of England was ever submerged to a greater depth during those periods.[3]

I cannot, therefore, agree with my friend Mr. Mackintosh, further than admitting that the sea, in Pre-glacial times, acting along lines of weakness, caused by faults and anticlinal axes, produced hollows of undulation, which determined the way water should flow, and in which rivers and brooks should cut down the step-like gorges of our existing Lake-district.

To those who state, with Prof. Sedgwick, that the proof of the limited excavating power of rivers in the lake district is being furnished by the small quantity of detritus they have yet been able to deposit in the lakes which receive their waters; it may be replied, first, that the lakes not only receive their waters, but also deliver them; that the lakes, almost without exception, are nothing but expanded rivers carrying detritus, not into lakes, but into the sea. To take an instance: Codale and Easedale Tarns flow into Grasmere, the latter into Rydal Water, whose waters, flowing down the Rothay, enter Windermere. Blea Tarn, Langdale Tarn, Stickle Tarn, Elter Water, all flow into Brathay, which, after falling over

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[1] Hull, Mem. Lit. Phil. Soc., vol. ii., etc., p. 455.

[2] Darbishire, Geol. Mag., Vol. II., p. 303.

[3] These three Drifts do not occur in the Lake-district, and true *Moraine Drift* descends as low as 100 feet above sea level.

Skelwith Force, and receiving the drainage of Loughrigg Tarn, joins the Rothay and falls into Windermere, which also receives Blelham Tarn, Esthwaite Water, Out-Dubs Tarn, and other small lakes; the Lake Windermere itself flows down the Leven, a considerable river, of which the River Crake, which drains Coniston Water, is a tributary. The two rivers unite at Greenodd and flow into Morecambe Bay, between Ulverstone and Cartmell. The Leven, at its mouth, therefore, contains the drainage of at least twenty lakes, of which five are of considerable size, and I think few can doubt that this river has been partly instrumental in the formation of "Morecambe Sands." And, secondly, again considering the immense depth of some of the lakes, the deep chasms in which they lie, it is impossible to say that there are not immense quantities of detritus concealed beneath their placid waters. At the time of my visit last month, from the dryness of the season, the heads of many of the lakes were dry, and I was, therefore, able to examine several of them, and I found the bottom invariably to consist of fine alluvial sand, capped by a thin coating of peat or vegetable growth; a section through one of these deposits would probably exhibit a succession of thick bands of alluvium, and thin seams of peat, the former thrown down in winter, the latter formed in summer; in this way several tracts have been reclaimed at the heads of several of the lakes.

I have been induced to publish the above hasty notes, because, with the exception of Mr. Mackintosh's paper, to which I have so often referred, little has been printed on the Surface-geology of the district. I have abstained from giving any sections of details, leaving them to the more able hands of those officers of the Geological Survey, who are now engaged in the survey of that region.

On my way south, I called on Mr. Bolton, of Ulverstone, the author of a most interesting work on the geology of Furness (the result of more than seventy years' labour), who showed me blocks of limestone bored with holes from the neighbouring mountains, and other blocks from the sea-beach of Walney Island, also composed of Carboniferous limestone, with similar holes, in each of which may be seen the two perfect shell-valves of a *Pholas*. But none of the holes were quite so large as those described to me by Mr. Mackintosh, as occurring in the block he sent up to the Geological Society.

IV.—ON THE OCCURRENCE OF PLANTS IN THE SKIDDAW SLATES.

By HENRY ALLEYNE NICHOLSON, M.D., D.Sc., M.A., F.G.S., Lecturer on Natural History in the Extra-Academical School of Edinburgh.

(PLATE XVIII.)

THE occurrence of plant-remains in the Silurian and Cambrian rocks is a subject of great interest, but one which has not hitherto been sufficiently investigated. Many supposed plants have been described by Emmons, Hall, Billings, and Dawson, from the older Palæozoic rocks of North America, and little doubt can be ieol. Mag. 1869.

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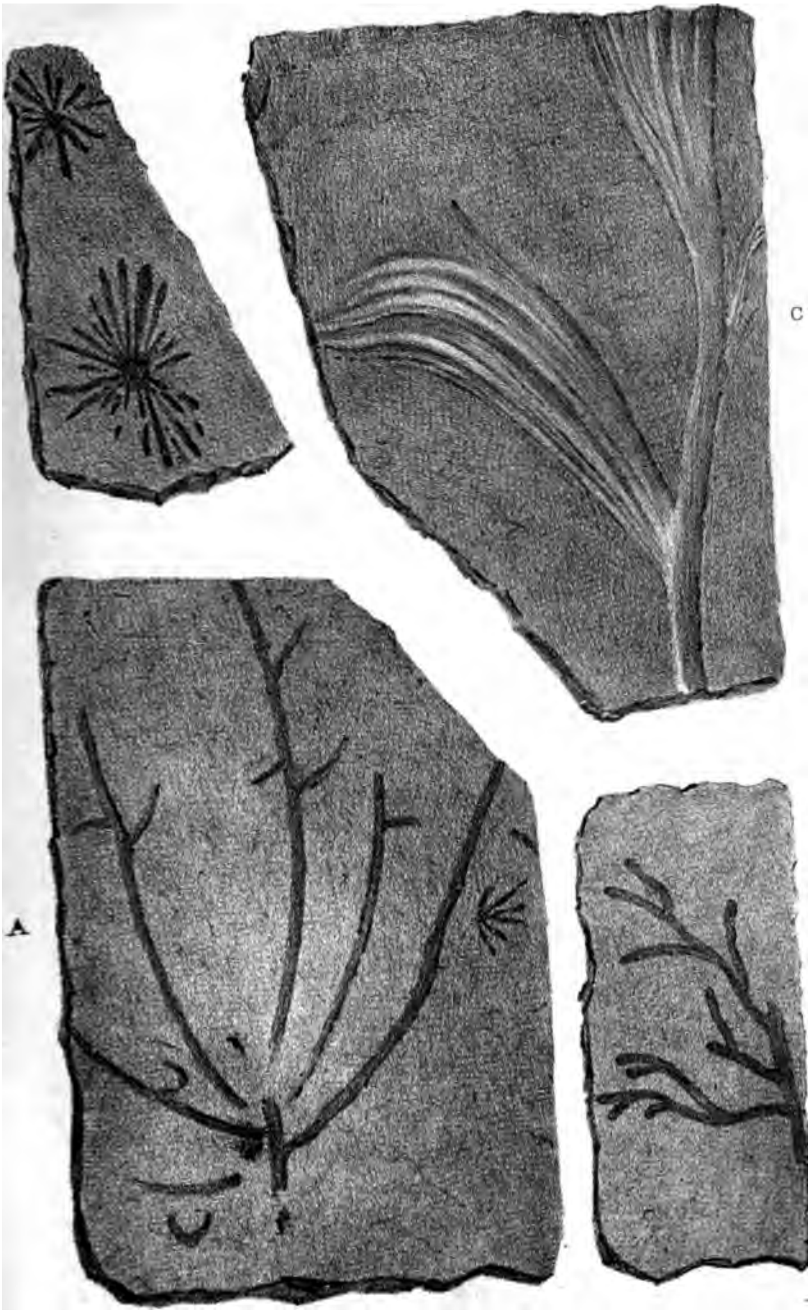

G. R. De Wilde. del et lith.

Plants from the Skiddaw Slates.

entertained of the vegetable nature of some even of the most ancient of these. Many, however, as believed by Professor E. Forbes and Mr. Salter, are certainly referable to the tracks or burrows of marine animals. More recently the Cambrian rocks of Sweden have yielded to the researches of Torell and Linnarsson some remarkable impressions and casts of fossils, which are believed to be of a vegetable nature (Geol. Mag., September, Vol. VI., p. 393, Plates XI., XII., and XIII.). In Britain there is not, as far as I am aware, any instance of the occurrence of plant-remains in deposits of Lower Silurian age, as to the nature of which all authorities are agreed.[1] The *Oldhamia* of the Cambrian rocks is believed by Mr. Salter to be a plant, but good authorities would place it either amongst the Polyzoa or Hydrozoa. The *Cruziana semiplicata* of the Lingula Flags has often been assigned to the Fucoids, but it is believed by Mr. Salter to be "the filled-up burrow of a marine worm" (Mem. Geol. Survey, vol. iii., p. 248). Long ago Professor McCoy described from the Skiddaw slates (lowest Llandeilo) certain fossils which he believed to be fucoids (Quart. Journ. Geol. Soc., vol. iv., p. 223, and Pal. Foss., pl. i. A). After studying a large number of specimens, however, I have been compelled to come to the conclusion, held by Mr. Salter and Professor Harkness, that these fossils (viz. *Palæochorda major*, *P. minor*, and *Chondrites acutangulus*) are truly referable to the action of marine worms. Within the last few years, however, I have obtained from the Skiddaw Slates several fossils, which certainly do not admit of being explained in this manner, though I would not go so far as to assert that they are unquestionably plants. The age of the deposit in which they occur renders them, at any rate—whatever their true nature may be—of sufficient interest to merit a short description.

Buthotrephis Harknessii, n. sp. (Pl. XVIII., Fig. A). In his Palæontology of New York, Professor Hall describes several species of plants under the generic name *Buthotrephis*, their range in time extending from the Calciferous Sandstone up to the Clinton Group (Upper Silurian). The characters assigned to the genus are as follows:—"Stems sub-cylindric or compressed, branched; branches numerous, divaricating, leaf-like: structure vesicular"? (See Pal. N. York, vol. i., p. 8.) The nature of the fossils described under this head is such as to show clearly that, if not of vegetable origin, they are certainly not referable to the operations of Annelides, Molluscs, or any other animals. This is proved by the fact that they are always more or less regularly branched; and also by their not being simple impressions on the sediment, but by their possessing, on the other hand, a true organic structure, differing in colour and grain from the surrounding matrix, and sometimes even exhibiting a carbonaceous texture.

In the upper beds of the Skiddaw Slates, I have found specimens of a fossil apparently belonging to the genus *Buthotrephis*, and bearing considerable resemblance to *B. gracilis*, more especially to the variety

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[1] With the details of Mr. Hicks's recent discovery of plants in the Cambrian Rocks of St. David's I am not acquainted.

crassa, described by Hall from the Clinton Group (Op. cit. vol. ii., pl. v. fig. 3). The characters, however, of these fossils are so little definite, and the above-mentioned species is so variable, that I have not thought it safe to include our specimens under it, more especially as they exhibit some curious points which are not present in the American form. The fossil in question shows unequivocal organic structure, consisting of dark, nearly black, cylindrical, regularly branching stems, usually about a line in width, which can not be obtained in relief, as they split right through when the shale is laid open. The best specimen which I have found is broken, and consists of a central stem giving off alternately on both sides long secondary branches, which diverge at angles of from 25° to 60°. The terminations of none of these branches are shown, though one attains a length of nearly three inches; nor is any diminution in their diameter observable. The secondary branches in turn bear, at irregular intervals, on both sides, short tertiary offsets, which taper rapidly to a point, and would seem, therefore, to be of the nature of leaves, rather than the bases of fresh branches, though it is not possible to be quite certain of this.

This singular fossil is unquestionably the remains of some organism, and cannot be referred to the action of marine animals of any kind. Its regular mode of branching demonstrates this beyond a doubt. The proofs of its being a vegetable, though less strong, are, I think, sufficiently weighty, more especially as it is difficult to see what else it could possibly be. If it were a Sponge, a Polyzoon, or a Cœlenterate of any kind, it would almost infallibly exhibit some structure by which this could be certainly determined, the nature of the sediment being such that the most delicate details—as shewn by the accompanying Graptolites—would be preserved. It is not, however, siliceous, chitinous, or calcareous, and it is merely of a much coarser grain than the enveloping matrix. As to its place in the vegetable kingdom, it were premature, in the absence of perfect specimens, to offer any decided conjecture, though the mode of branching would not lead us to refer it to the Algæ. Hall, however, thinks that *Buthotrephis* is "doubtless allied to the recent Fucus," and it certainly presents some resemblance to the "fucoids" of the lower Ludlow Rock of the neighbourhood of Ludlow.

Loc.—Upper beds of the Skiddaw Slates, Thornship Beck, near Shap.

Buthotrephis (?) *radiata*, n. sp. (Pl. XVIII. Fig. B.).—This fossil occurs only in conjunction with the preceding, and in exactly the same state of preservation, so that there is some reason to think that they are different portions of the same organism. From the contiguity of the two in some specimens—though this, of course, may be accidental—I have been led to think it possible that this form may in reality be the whorled leaves of *B. Harknessii*, but I have never seen them in direct connection. Its description, however, as a distinct species must be regarded as simply provisional, and I have placed it in the genus *Buthotrephis* only in view of its probably being a fragment of another form.

B. radiata consists of detached whorls of tapering leaves (?), meeting in a common centre, narrow at their origin, and gradually widening out to terminate in blunt rounded extremities. The size of the whorls varies a good deal, the shape being circular or somewhat elliptical. The number of rays in each whorl varies from ten to twenty-five, their length being from a quarter to more than three-quarters of an inch, and their breadth at the extremities being from one-twentieth of an inch to over a line. The colour of the fossil is nearly black, and its texture, like that of the last, is of a much coarser grain than the enveloping matrix.

It is even more difficult than in the case of *B. Harknessii* to imagine what this can be if not a plant, its form not being that ordinarily assumed by phytoid animals. It seems, however, pretty certain that if its vegetable nature be conceded, it can hardly be referred to the Algæ.

Loc.—Upper beds of the Skiddaw Slates, Thornship Beck, near Shap.

Eophyton (?) *palmatum*, n. sp. (Pl. XVIII., Fig. c.)—Unlike the two preceding forms, this exhibits no distinct organic structure, but presents itself merely as an impression upon the surface of the stone. The texture of the rock is so coarse that nothing further than the shape of the fossil can be stated. It consists of a central stem, about two lines in width, which gives off alternately on both sides fan-shaped expansions, which are narrow at their origin, but widen out rapidly till a breadth of about three-quarters of an inch may be attained. A similar fan-shaped expansion terminates the stem, and all are marked with numerous sub-parallel or slightly diverging ridges.

Having only a single fragmentary specimen, it is not possible to fix accurately the position of this fossil, but it agrees in its longitudinal furrowing with *Eophyton*, and may be placed here in the meanwhile. Its characters are, I think, such that it can hardly be ascribed to the action of marine worms, and it is chiefly for this reason that I have been induced to describe it. It also exhibits a much greater affinity to the Algæ than does either of the previously described forms.

Loc.—Lower beds of the Skiddaw Slates, Barff, near Keswick.

Chondrites (?) (Pl. XVIII., Fig. D.)—Besides the above I possess a specimen from the Skiddaw Slates which is, probably, referable to the genus *Chondrites*. I do not describe it, however, as it possibly may belong to the *Graptolitidæ*, and its state of preservation is such that this point can not be decided. It consists of a branching and re-branching frond, the branches of which have a uniform width of little less than a line, and terminate in rounded extremities. The branches are flexuous, and are given off alternately in a sub-dichotomous manner. The surface of the specimen is so much discoloured with iron that no details of structure can be made out.

Though larger and less branched, this fossil is not unlike the *Chondrites verisimilis* of the Ludlow Rocks of the Pentland Hills, which Mr. Salter fully admits to be a true fucoid (Mem. Geol. Survey of Scotland, No. 31, p. 134). As many branched Graptolites, however, occur in the Skiddaw Slates, and as this exhibits no structure, it is safest to leave its position an open question.

Loc.—Lower beds of the Skiddaw Slates, Rake Beck, near Melmerby.

In addition to the above-described obscure but interesting fossils, the Skiddaw Slates yield numerous specimens which might be referred to the genus *Palæophycus* of Hall. I should, however, be certainly disposed to think that most, if not all, the fossils referred by Hall and Billings to this genus are truly of the nature of worm-tracks and Annelide-burrows.

Having recently obtained several new forms from the Skiddaw Slates, I may conclude with a list of the fossils known to me as occurring in this formation.

LIST OF FOSSILS FROM THE SKIDDAW SLATES.

CRUSTACEA.
Æglina binodosa, Salt.
„ *caliginosa*, Salt.
Agnostus Morei, Salt.
Caryocaris Wrightii, Salt.
Leperditia (?)
Ogygia (?)
Phacops Nicholsoni, Salt.
Trinucleus Gibbsii, Salt.
ANNELIDA.
Tracks and burrows (*Arenicolites*, *Scolites*, and *Helminthites*.)
BRACHIOPODA.
Discina (?)
Lingula brevis, Portl.
HYDROZOA (*Graptolitidæ*).
Climacograpsus antennarius, Hall.
„ *bicornis*, Hall.
„ *teretiusculus*, His.
Dendrograpsus Hallianus, Prout. (?)
Dichograpsus annulatus, Nich.
„ *fragilis*, Nich.
„ *Logani*, Hall.
„ *multiplex*, Nich.
„ *octobrachiatus*, Hall.
„ *reticulatus*, Nich.
Didymograpsus affinis, Nich.
Didymograpsus bifidus, Hall.
„ *fasciculatus*, Nich.
„ *geminus*, His.
„ *nitidus*, Hall.
„ *patulus*, Hall.
„ *serratulus*, Hall.
„ *sextans*, Hall.
„ *V-fractus*. Salt.
Diplograpsus armatus, Nich.
„ *Hopkinsoni*, Nich.
„ *mucronatus*, Hall.
„ *pristiniformis*, Hall.
„ *pristis*, His.
Phyllograpsus Anna, Hall.
„ *angustifolius*, Hall.
„ *typus*, Hall.
Pleurograpsus (?) *vagans*, Nich.
Tetragrapsus bryonoides, Hall.
„ *crucifer*, Hall.
„ *Headi*, Hall.
„ *quadribrachiatus*, Hall.
Trigonograpsus lanceolatus, Nich.
PLANTÆ (?)
Buthotrephis, *Harknessi*, Nich.
„ (?) *radiata*, Nich.
Eophyton (?) *palmatum*, Nich.
Chondrites (?)

EXPLANATION OF PLATE XVIII.

Fig. A.—*Buthotrephis Harknessi*, sp. nov. nat. size.
Fig. B.— „ (?) *radiata*, sp. nov. „ „
Both from the upper beds of the Skiddaw Slates, Thornship Beck, near Shap.
Fig. C.—*Eophyton* (?) *palmatum*, sp. nov. nat. size. From the lower beds of the Skiddaw Slates, Barff, near Keswick.
Fig. D.—*Chondrites* (?), nat. size. From the lower beds of the Skiddaw Slates, Rake Beck, near Melmerby.

V.—ON THE CONNECTION OF THE GEOLOGICAL STRUCTURE AND THE PHYSICAL FEATURES OF THE SOUTH-EAST OF ENGLAND, WITH THE CONSUMPTION DEATH-RATE.

[A paper read before the Geological Society of London, June 23, 1869.]

By WILLIAM WHITAKER, B.A. (Lond.), F.G.S., of the Geological Survey of England.

ALTHOUGH the subject of this paper has already been discussed in detail,[1] yet, as this has been done from a medical rather than from a geological point of view, it may be well that the chief facts of the case, the method of investigation followed, and the conclusions come to, should be brought before the Geological Society; for the Society will not fail to have an interest in noting what a practical bearing our science has on the health, as it has long been known to have on the wealth, of mankind.

In 1865 my friend, Dr. Buchanan, was appointed by the Privy Council to inquire into the results of sanitary improvements in England. With this object he visited twenty-five large towns in which various works, designed to promote the public health, had been for some years in operation; and studied whether any change for the better, in the general health of the population, had taken place since the establishment of those works, and if so what that change was.

The result of this enquiry was published in the Report of the Medical Officer for 1866, and whilst showing, as was expected, that the death-rates from fever, cholera, &c., had been lowered, it also led to the quite unexpected conclusion that consumption had been very materially affected. This disease however had not decreased in all cases, and on examination it turned out that *the lowering of the consumption death-rate went along with the decrease of water in the subsoil by improved drainage*, but did not steadily go along with any other sort of improvement.

The most marked instance of this is Salisbury, where the death-rate from consumption, since the new drainage-works have been in use, is about half what it was before. Taking that death-rate, before the establishment of the sanitary works, at 100, the new rate is 51. The next town on the list is Ely, where, on the same principle, the new rate is 53, whilst at Rugby it is 57, at Banbury 59, at Worthing 64, at Leicester and Newport 68, at Macclesfield 69, at Cheltenham 74, at Bristol 78, at Dover 80, and at other towns there has been an improvement in less degree.

These figures, which are calculated from the death-rates over a number of years (as no safe conclusion could be come to from the statistics of a very short time) seem, when it is shown that no other sanitary work had any particular effect, to be conclusive as to the connection between land-drainage and consumption. They suggested to Dr. Buchanan that it might be well to see whether natural causes that affect the saturation of the subsoil had not also some connection with consumption; or in other words, whether places on those geological formations that allowed the free drainage of water would not have a lower consumption death-rate than places on less pervious or damper beds.

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[1] Report of the Medical Officer of the Privy Council for 1867, pp. 14–17, and 57–110. 8vo. London, 1868.

Dr. Buchanan having been commissioned to undertake a further enquiry, with the object of bringing new facts of this kind into evidence, application for the needful geological data was made by the Medical Officer of the Privy Council to the Director-General of the Geological Survey, and of course all the information in the possession of the Survey was placed at Dr. Buchanan's disposal.

After a little consideration we saw that it would be useless to take up for examination any district in which the surface-deposits of gravel, etc., had not been mapped, as well as the regular formations; and also that it would not do to take small areas scattered here and there about the kingdom: one large connected tract was essential for any trustworthy result. This at once limited the range of the enquiry to the South-East of England; for only in the counties of Kent, Surrey, and Sussex (or part thereof), had the Geological Survey mapped those surface-deposits (with some exceptions of no great importance here). There are other tracts—as in Lancashire—where the drift has been mapped, but they are of much smaller extent. This limitation having been made, I was instructed to give Dr. Buchanan all the help in my power, and consequently I worked with him for some little time, referring to my colleagues for information as to districts that were out of my own personal knowledge.

Luckily for the enquiry the aforesaid three counties have other recommendations. They are without any great manufacturing industry; and the conditions of life in factories had been proved, by previous investigations, to have an influence of their own upon the disease in question: they have great variety of soil, and yet their geological formations have, for the most part, a continuous outcrop, and often take up broad tracts; and they have many different conditions of surface, but without the level of the ground being subject to too abrupt changes, such as would be found in mountainous districts.

The metropolitan parts of Kent and Surrey had of course to be left out of consideration, as it would be quite hopeless to investigate a place like London, in which there are so many disturbing causes, such as the presence of large hospitals and the exceptional industrial conditions of the population.

It is needless for me to enter here into the purely statistical part of the enquiry, or the various allowances that had to be made for the influence of public institutions; for the influx of visitors to places supposed to be good for consumption; for wrong returns of the causes of death, &c.; enough to say that all these things were carefully taken into account by Dr. Buchanan.

The geological part of the enquiry was two-fold, embracing in the *first* place the consideration of the composition and character of the formations of the three counties, and the description of the stratigraphical conditions and physical features of the 58 districts which supplied the statistical data; and, in the second place, being directed to an estimation of the number of people living on each formation. In the former of these the knowledge of my colleague, Mr. Topley, was made use of for part of the Wealden area; whilst Mr. Bristow gave some information on the southern edge of Sussex and Hampshire, a very small part of which latter county came within the bounds of Dr. Buchanan's work.

The geological formations of the South-East of England range from the Bagshot Beds down to the Hastings Beds, without any gap, the series being perfect. Besides these there are alluvial flats, both as broad marsh-lands and as narrow strips along streams; fringes of shingle and blown sand along parts of the coast: and a great number of tracts of Drift loam, gravel, and sand on all formations, at many levels, and of various sizes.

In working out conclusions from the data that had been got together it is clear that, as saturation of subsoil was the chief thing to be considered, the mere permeability or impermeability of a formation was not the only condition to be examined; but that the height and slope of the ground and the dip of the beds were important matters, as well as any other fact that bore on the water-holding power of the beds or their capacity for drainage in any district.

From the varying character of some of the formations (as for instance the Lower London Tertiaries, the Lower Greensand, and the Hastings Beds), great care had to be taken to avoid hasty generalisations, and a detailed consideration of each particular district was made needful, the same formation having different characters, and giving rise to different physical features and conditions in different parts.

Again, though a formation, as the London Clay, might be of the same character throughout the whole area, yet any generalisation at once founded on that fact might have been false; for it was soon found to be absolutely essential to consider how the country formed by such a homogeneous formation is modified by the occurrence of cappings of gravel, &c., districts of bare clay being practically quite distinct from those where the clay is covered by 10 or 20 feet of pervious gravel.

This detailed method of examination sometimes showed that large areas formed of like beds, and which at first sight might have been thought to be of like character, were really far from being so: thus the London Clay and the Weald Clay are both thick masses of impermeable beds of much the same composition, but the broad tracts over which they crop out are for the most part quite unlike. The differences between the two great clay-countries of the South-East of England are so many that perhaps they may be best shown when thrown into the form of a table, as below, from which it may be seen that, whereas the London Clay is so disposed as for the most part to allow of the flowing off of surface-water, the Weald

Clay is favourable for holding back the same, and therefore the districts formed by the two clays are quite different in this important particular.

Comparisons of the Districts taken up by the Outcrops of the London Clay and of the Weald Clay.

London Clay.	Weald Clay.
(1). Often covered by gravel, especially in the populous districts.	(1). Less covered by gravel.
(2). The capping of gravel is mostly of fair thickness.	(2). The gravel is comparatively thin, and often insignificant.
(3). Forms a comparatively high country (except in the gravel-flats bordering the Thames), and is not closely bordered by higher ground of other formations.	(3). Forms a low country, bordered on both sides by higher ground.
(4). Has, for the most part, a gently undulating surface (except for the gravel-flats).	(4). Forms a flatter country, less varied by undulations, and those of less height.
(5). With comparatively few rivers, and those almost wholly from its own drainage (except where the larger rivers flow directly across it, through valleys).	(5). Is a channel for many rivers, which carry off not only its own drainage, but also that of the higher ground on either side, and which meander over it for long distances, and with slight fall.

At first sight, and in a purely geological aspect, the general result of the enquiry might be summed up as follows: that the consumption death-rate varies roughly as the age of the formations (disregarding alluvium, gravel, &c., which are distributed pretty fairly over all): the districts of the Tertiary beds and the Chalk holding, as a rule, the highest place, that is to say having the lowest death-rate; those of the Wealden beds taking the lowest place; and those of the intermediate Greensand, &c., coming in the middle. But this would give a very illusive view, for there are many exceptions.

Two methods of analysis of the obtained facts were used by Dr. Buchanan. Firstly, grouping the registration-districts in their order of consumption death-rate, to see what proportion of the population, in each group, live on pervious or impervious soils. For this purpose fifty of the districts (the remaining eight being left out as having exceptional characters, and needing further examination) were classed in five groups of ten each, with the following result:—

Groups of Ten Registration Districts.	*Percentage of Population.* On Pervious Soils.	On Impervious Soils.
1. With Lowest Consumption Death-rate ...	90·9	9·1
2. „ Higher „ „ ...	87·7	12·3
3. „ „ „ „ ...	79·5	20·5
4. „ „ „ „ ...	79·2	20·8
5. With Highest Consumption Death-rate ...	64·2	35·8

These gross results, though at first sight more exact than the rough general result first given, are however open to many objections, one of the chief, in a geological point of view, being that the physical features of the districts are not taken into account, and therefore the classification of the soils as pervious and impervious is in some cases delusive; for a very low-lying tract of pervious beds may, from its position, be saturated with water that cannot escape, and would therefore be in no better case, as regards the draining away of water, than a tract of impervious beds; indeed not so well off perhaps as a high-lying sloping tract of the latter kind.

The second method of numerical analysis adopted by Dr. Buchanan was calculated to lead to more exact and valuable results. Its plan was, to quote his own words, "to select out of the fifty-eight districts such as are most comparable with each other in regard of their position and geological structure, and to see how their phthisis is affected by the perviousness or imperviousness, elevation or lowness, slope or flatness, in the members of such more limited series," a method which involved various comparisons of districts and formations.

Firstly, as regards the amount of consumption on pervious soils from which water can drain away, compared with that on more impervious or retentive soils. The great tract known as "the Weald," contains within itself good materials for such a comparison, the districts that are chiefly on the more sandy and more sloping Hastings Beds contrasting with those on the flatter Weald Clay. In no case indeed is a district wholly sand or wholly clay, but the proportion of the population living on clay or on sand varies greatly; moreover many of the districts are partly on other formations. Parts where the Weald Clay is covered by gravel, being of an intermediate character, were treated as half pervious and half retentive. There were found to be fifteen registration-districts in which the greater part of the population lived on the various divisions of the Wealden series, and an examination of these showed that the districts with the higher consumption death-rates have the larger proportion of their population on retentive beds, and that those with the lower rates have the larger proportion on the more pervious beds; the numbers varying from 95 per cent. of the population on pervious, and 5 per cent. on retentive soils in the case of Hastings (which, after proper correction has been made for the influx of invalids, seems to be the second best district on the Consumptive Bill of Health), to 30 per cent. and 70 per cent. respectively in the case of Petworth, which is the worst district but two out of the whole fifty-eight.

Like results were got by the comparison amongst themselves of the ten districts in which the greater part of the population live on the Lower Greensand.

Secondly, a comparison was made between districts composed mostly of pervious soils at a fair height and with a good slope, in short in which there were good facilities for the draining away of water; and other districts of like beds, but which from their position and character were more liable to saturation. In this case the slope of underlying impervious beds is sometimes important, as a shallow basin of sand or gravel on clay is favourable for the holding rather than for the flowing off of water. From this comparison, it was found that districts mainly on a set of pervious beds (whether of gravel over London Clay, of the sandy and pebbly Lower London Tertiaries, of Chalk, or of Lower Greensand) and which have a fair general height, and a fair slope of surface, have a lower consumption death-rate than other districts on the same formations, but at lower levels, and with flatter surfaces.

There is one remarkable kind of exception to this rule. It is that the low-lying tracts of shingle bordering the shore, and saturated more or less by sea-water, seem to be not badly off in respect of consumption,—Dover, where a large part of the population live on shingle, being a notable case in point.

Thirdly, districts chiefly of impervious formations were examined with regard to their physical features; the higher and more sloping, which allow of the flowing off of surface-water, being compared with those that are lower and flatter, and on which therefore water rests longer. This of course was little more than a comparison of the two great clay-tracts, those of the London Clay and of the Weald Clay, the physical differences of which have been noticed before (p. 502).

The gravel-covered London Clay ranges itself amongst the pervious formations, but a comparison of the two clays when bare shows a great difference in their consumption death-rate. Many districts have a goodly proportion of their population on the sloping London Clay without their consumption being much affected, whereas in those that have much population on the flat Weald Clay the death-rate is high; so that here again wetness and consumption go together.

The few exceptions are perhaps one of the best proofs of the rule. On those parts of the South Coast where a large population lives on London Clay the consumption is very high,—Chichester indeed standing worst of the fifty-eight districts. Now in that country the London Clay has not its usual features, but forms a more or less gravel-covered, low-lying, water-logged flat, being (exceptionally) much in the usual condition of the Weald Clay.

As the shingle-tracts bordering the sea seem to be an exception to the rule that low-lying pervious beds are much worse off than those at higher levels; so the alluvial flats bordering the sea seem to form an exception to the rule amongst impervious beds, the striking case being Sheppey, which stands at the head of the whole fifty-eight districts, although the greater part of its population live on alluvium, close to the sea, and at about the sea-level. One is led to think therefore that saturation by sea-water and saturation by fresh-water are quite different matters, and that whereas the latter increases the consumption death-rate, the former is comparatively harmless, or perhaps even beneficial. Sea air too may be good for consumptive patients.

The conclusions that result from the geological and statistical examination of the counties of Kent, Surrey, and Sussex, of which an outline has been given above, are as follows :—

(1). *That on pervious soils there is less consumption than on impervious soils.*

(2). *That on high-lying pervious soils there is less consumption than on low-lying pervious soils.*

(3). *That on sloping impervious soils there is less consumption than on flat impervious soils.*

(4). These inferences must be put along with the other fact, that *artificial removal of subsoil-water, alone, of various sanitary works, has largely decreased consumption.*

From which follows the general inference, that WETNESS OF SOIL IS A GREAT CAUSE OF CONSUMPTION, no other condition having been found, in the course of these inquiries, to go along with the consumption death-rate to any great extent.

The value of such a conclusion, should it stand the test of further examination, cannot I think be over-estimated. It would introduce a new principle and object into the carrying out of those drainage-works that have been so much called for of late; it would aid consumptive people in choosing healthy living-places, and in avoiding those that may be hurtful; it would lead to the lessening of a disease that is the special curse of our country; and, by bringing men of science something nearer to the knowledge of the first cause of consumption, it might lead to the discovery of that cause, and of such treatment and remedies as would successfully grapple with the disease.

Confirmatory and independent evidence of the truth of the above conclusion comes to us from America, Dr. Bowditch having drawn attention, in 1862, to the fact that "medical opinion in Massachusetts . . . . tends strongly to prove . . . . the existence of a law in the development of consumption in Massachusetts . . . . that dampness of the soil . . . . is intimately connected, and probably as cause and effect, with the prevalence of consumption."[1] The Registrar-General for Scotland, quoting the above (in his Seventh Annual Report), and applying it to eight large towns in Scotland, accepts the theory. It is right to add however that no such detailed examination, as in our case, seems to have been made in either America or Scotland.

NOTICES OF MEMOIRS.

I.—EXPERIMENTS ON CONTORTION OF MOUNTAIN LIMESTONE.[2]

By LOUIS C. MIALL, Esq.

IT has been well established by numerous experiments that no rigid body is either quite inflexible or perfectly elastic. All bodies are altered in form by pressure, and every change of form produces some permanent alteration, however slight, either in shape or texture. When any substance is bent, the total deflection is made up of two elements, which may be termed *elasticity* and *set*, or temporary and permanent deflection.

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[1] "Consumption in New England and elsewhere, or Soil-moisture one of its chief causes." Ed. 2. Boston, 1868. I should state that Dr. Buchanan did not know of this pamphlet until the completion of his own researches.

[2] Read before the British Association (Section C.) at Exeter, August, 1869.

The practical importance of this distinction in iron-work has led to valuable investigations respecting the changes produced in that metal by strains. Mr. Hodgkinson and Mr. Fairbairn have prepared tables which give the results of many experiments of this kind. More recently, M. Tresca has investigated the subject, and his paper on the "Flow of Solids," read before the Institution of Mechanical Engineers at Paris in 1867, contains an account of various experiments instituted to prove that the behaviour of liquids under pressure is only one case of a general law, which may be extended to solids also, being of course particularly conspicuous in those solids which, like iron and lead, possess a marked ductility.

The geologist is aware that rocks also are capable of both temporary and permanent deflection. Contorted rocks, of which a vast number of examples are known, shew that in many cases compact and solid strata have been crumpled up like folds of cloth, while the contained fossils have been occasionally curiously distorted, yet without fracture. It is quite unnecessary to cite instances of what is well-known to all students of geology. From the earliest days of the science these phenomena have been referred, and no doubt justly, to slow and long continued pressure. But I am not aware that the matter has ever been investigated with quantitative precision, and the experiments which I am about to quote were accordingly directed to this issue—an exact comparison of sudden and continuous strains with reference to the deflection which they can respectively produce.

The apparatus which has been contrived to prosecute this inquiry is of a simple kind. The machine here exhibited is adapted for producing visible deflection in thin slabs of stone. The lamina is clamped at one end of a block, the length to be bent is regulated by sliding the block along a groove, and a known weight descends upon the free end. Provision is made that the weight shall act upon a knife-edge, which is always perpendicular to the surface of the slab and always applied to the same line. By means of an index, the deflection can be read accurately to hundredths of an inch.

With this apparatus I have made experiments for some months past, but the process is so slow, several weeks being required for one operation, that the results hitherto arrived at are very limited. I have as yet tested carefully no material except mountain limestone, and there is still much to be done in studying the effect of small but long continued strains upon that substance.

The annexed table gives the results of one series of contortion experiments. A number of observed facts have been neglected in order to give prominence to the chief point, viz. the difference in the deflections which may be produced by the sudden application of a considerable weight and the prolonged action of slight pressure. The angles have been deduced from the amount of perpendicular deflection, and they are consequently all taken as rectilinear.

Experiments on Contortion of Mountain Limestone.

No. 1. $\frac{7}{100}$ in.

2lbs. Immediately (broke at) 2·2°	7oz. 3 weeks 7·4°	7oz. 2 months 11·5°	Recovered in 3 weeks 2·7°

No. 2. $\frac{6}{100}$ in.

2lbs. Immediately (broke at) 2·5°	7oz. 3 weeks 8·15°	7oz. 2 months 10·15°	Broke after 6 days

No. 3. $\frac{7}{100}$ (bituminous).

2lbs. Immediately (broke at) 2·75°	7oz. 3 weeks 7·55°	7oz. 2 months 11·2°	Recovered in 3 weeks 3·1°

No. 4. $\frac{8}{100}$ (bituminous).

2lbs. Immediately (broke at) 2·15°	5oz. 3 weeks 7·1°	5oz. 3 weeks 12·5°	Broke after 11 days

Another circumstance connected with these experiments has some interest in connection with geological phenomena. I have found repeatedly that the slabs, when bent to any considerable angle, have exhibited a great tendency to break transversely. This has generally appeared some days after the strain was removed. In those cases where sharp, unbroken bends occur in rocks, the tendency to fracture has been probably overcome by the pressure of superincumbent mass. As yet I have not been able to imitate the natural conditions so as to verify this explanation experimentally, but I have no doubt of its correctness. In one well-marked instance in the Mountain limestone district of Yorkshire an anticlinal flexure passes eastwards into an anticlinal fault with gradually increasing displacement. The geological evidence in this case shews unmistakably that the limestone was covered at the time of disturbance by a considerable thickness of upper Carboniferous strata, which are also known to have materially diminished eastwards,—that is, in correspondence with the alteration in the character of the anticlinal.

Some interesting facts have been observed by the microscopic examination of the deflected substances, but these results require more complete investigation. In order to operate upon thicker slabs, I am preparing a micrometer screw which will read deflection to 1-1500 inch. At some future time I hope to bring a fuller collection of observations under the notice of geologists.

II.—On Certain Phenomena in the Drift near Norwich.[1]

By John E. Taylor, Esq.

It has been well observed that in Norfolk we possess the best graduated series of later deposits from the Pliocene age upwards, to be found in Great Britain. With the exception of the "Purple Clay," found by Messrs. Wood and Rome in Lincolnshire, and believed by them to be of later date than the upper Boulder-clay of Norfolk, we have all the Pleistocene series complete. Notwithstanding this, there are few "debateable lands" more open to difference of opinion than those of Norfolk. Every now and then, the geologist who believes he has made out a complete case, and imagines he can rest on his oars, is suddenly disturbed by some out-of-the-way and apparently trivial discovery which upsets all his previous calculations, and forces him to his Sisyphus task again. I believe, however, that ultimately all these discrepancies will be found more fully to bear out the glacial hypothesis.

I have the honour to bring before the notice of this Section several phenomena which apparently disturb the succession of the drift-beds, but which in my opinion only confirm the theory of their origin. About three years ago, my friend Mr. Harmer, of Norwich, contributed a paper which was read before the Geological Society of London, on a "third, or Valley Boulder-clay." This deposit was found at Thorpe, near Norwich, and Mr. Harmer, who I believe has since altered his hypothesis, gave to it its name of "Valley Boulder-Clay," from finding it on the shoulder of the high grounds bounding the valley of the Yare towards the east. Subsequently I conducted Mr. Harmer to a similar deposit at Swainsthorpe, about five miles from Norwich, where the Boulder-clay is seen resting on the reconstructed Chalk, to the absence of the intervening series, which, however, are found to the north and south of this patch, at the distance of less than a quarter of a mile. All these beds occur on a plateau, away from any river valley. Again, at Harford Bridges, two miles from Norwich, a similar bed of Boulder-clay is seen lying at a lower level than the middle drift sands which occur about a quarter of a mile off. Last year, in company with Professor Liveing and the Rev. Osmond Fisher, I visited this bed, in order to point out the seeming anomaly, when Mr. Fisher suggested what I believe to be the true explanation in every case where the upper Boulder-clay lies out of its true position—that it had been thrown down in a deep furrow or groove formed by the stranding of an iceberg. Some of the localities where the phenomena I am about to mention occur, may have been in a continuous line of such iceberg action, and the intervening area may have been denuded into its present form, so as to cut off the connection.

In the cutting of a deep railway gulley, close by the well-known Crag-pit of Thorpe, near Norwich, there was laid open, about a couple of years ago, a section showing a north-easterly groove scooped out of the sand and pebble-beds, and having the Upper

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[1] Read before the British Association (Section C.), Exeter, August, 1869.

Boulder-clay dropped into it. The diameter of the furrow was about a hundred yards. On each side the sands were twisted and contorted, as though they had been acted upon by some moving mass, and thrown out of their original position. The Boulder-clay at Harford Bridges evidently rests on the disturbed Chalk, which comes up a little nearer Norwich, on the same side of the river. This bed cannot be more than two or three hundred yards in breadth, and it also has a north-easterly extension. On the higher grounds of Trowse and Bixley, the Upper Boulder-clay may again be seen resting on the disturbed Chalk, although less than a quarter of a mile away, in the same line of high ground, there is a pit where the Crag is developed, with the pebble-beds and clays overlying it, the whole resting on the hard and undisturbed Chalk. Mr. Searles Wood, in a paper read before the British Association at Norwich, last year, stated what he called an "anomalous structure in the Upper Glacial beds." This was that the true Boulder-clay in the centre of Norfolk has been deposited in a great trough more than twenty miles in breadth. It is evident that this has no connection with the minor phenomena I have endeavoured to describe, although this great sheet also is let down on the Chalk. Such an extensive result may, however, be directly connected with the general glaciation of the Norfolk Chalk-beds.

At Drayton, about three miles from Norwich, and again at Attlebridge, about four miles further, the same phenomenon of the grooving of the Lower Drift-beds and the deposition of the Boulder-clay in the hollow, may also be seen, although here the surface of the country must have suffered considerable denudation since it occurred. In none of these instances is the width of the Boulder-clay deposit more than a few hundred yards. Another phenomenon seems to have more or less of a connection with those I have described. Close by the patch of Boulder-clay at Swainsthorpe, and on the same general level, the re-deposited Chalk crops up, and the flint bands may be seen contorted and dragged up into an angle of nearly sixty degrees. At Whitlingham, between the patches of Boulder-clay, lying out of their true places at Thorpe and Trowse, there is a fine section showing the flint bands in the disturbed Chalk thrown into quite an anticlinal axis, although a few hundred yards to the right and left of the same bed, they are in almost their original horizontality. It would seem as if the agent which had furrowed and displaced the Lower Drift-beds, and caused the Upper to be deposited in the hollow, had also dragged up and twisted the flint-bands in the Chalk along its course, just as I have mentioned its having contorted the sand-beds in the railway cutting. The occurrence of the two phenomena so near together is certainly suggestive. If the Upper Boulder-clay was formed under glacial-marine conditions, the stranding of icebergs must have been of frequent occurrence, so that phenomena like those I have mentioned only prove the general fact. Thus viewed, these seeming anomalies fall into their proper places, and complete the evidence of the semi-arctic circumstances under which some of the Drift-beds of Norfolk were accumulated.

REVIEWS.

I.—The Natural System of Volcanic Rocks. By F. Baron Richthofen, Dr. Phil. Printed by the California Academy of Sciences, San Francisco, 1868.

IN a notice of the work of two French geologists on Central America in the last number of this Magazine, regret was expressed that imperfect ideas upon volcanic action had prevented their just appreciation and clear description of the geology of that district; especially of the great development of Trachytic rocks observable there. The same remark applies to the work named at the head of this paper by a German geologist, who, possessing the advantage of a previous acquaintance with the volcanic regions of Germany and Hungary, recently visited the North-west coast of America, and has dealt with the subject of volcanic rocks in an elaborate memoir presented to the California Academy of Sciences, and printed by them at San Francisco in 1868.

The value of M. Richthofen's "Natural System of Volcanic Rocks," as a contribution to the science of geology, may be estimated from the fact that he denies the occurrence of any volcanic rocks in the series of geological formations preceding the commencement of the Tertiary Era. (What will Sir Roderick Murchison, Professor Ramsay, or Mr. A. Geikie say to this?) And his "System of Volcanic Rocks" is divided into two great classes; the first and earliest that of "Massive Eruptions," which, though "volcanic," were "not produced by volcanos"; the second, and latest in time, the products of "Volcanos proper." M. Richthofen goes on to divide *each* of these two classes of rocks into five "orders," determined by their mineral characters, called by him respectively, 1. "Propylite" (Greenstone—Trachyte, or Greystone—*i.e.*, a Trachyte in which Hornblende or Augite occurs in noticeable quantity); 2. Andesite (a mere variety of the latter rock); 3. Trachyte proper; 4. Rhyolite (Siliceous Trachyte, Pearlstone, and Obsidian); 5th. Basalt. These different kinds of volcanic rock succeed one another, according to M. Richthofen, "invariably over all the globe," in the sequence here given, not once only, but twice over, that is, in each "class;"—in the earlier period of "massive eruptions," and in the later period of "volcanos proper."

It is needless to say that these arbitrary classifications and assertions as to the relative age of particular varieties of volcanic rocks are wholly at variance with known facts, and the authority of the most reliable observers of such formations.

The epithet "massive," applied by M. Richthofen to his class of earlier volcanic rocks, would seem to indicate some distinction founded on the vastness of the scale on which they occur, as compared with the "volcanic rocks proper." But see the following description by him of an admitted "volcano," Lassen's Peak, in Northern California (p. 33).

"The *enormous* bulk of this ancient volcano is totally built up of stratified layers of Andesitic tufa and lapilli, which, in the steep gorge issuing from its lower crater, are exposed in a thickness of nearly four thousand feet. . . . . Besides these *stupendous accumulations* of loose matter, currents of Andesitic lava appear to have been emitted from the crater, extending *at least twenty* miles from the place of ejection. At a later epoch, the activity of the same volcano has been distinguished by the emission of trachytic lava from the north-eastern part of the wall of the crater; its currents have expanded to *elongated* and sloping tables, bounded by abrupt descents. A third epoch is marked by the outbreak of rhyolite, at the same place whence the trachytic rocks had issued. Rhyolite composes the present summit of Lassen's Peak, on which it is accumulated in a thickness of *more than fifteen hundred* feet; also some other summits of less altitude, and at least one prominent current of lava of great volume."

If these "volcanic rocks," are not worthy of the epithet "massive," we may, at least, inquire how they are distinguishable from those massive rocks, of which M. Richthofen contrasts the "*Grandeur*" (p. 90) with the "insignificant processes of volcanic activity," and the same question may be asked in reference to all those hundreds of volcanic peaks and cones with which the Andes of both continents are studded, and which rise from 5,000 to 25,000 feet above their bases—all the acknowledged products of this "insignificant volcanic activity." The following is the only passage we can find in the memoir, in which any attempt is made to justify the two-fold division of "volcanic rocks." After admitting that "no distinct line of demarcation can be drawn between the two modes of manifestation of subterranean energy," he goes on to say, "But in numerous instances . . . conspicuous differences may be noted between them. *Volcanos are provided with a channel connecting the seat of volcanic action with the surface.* The matter which they eject consists either of stratified layers of ashes and scoriæ, or of currents of lava in the shape of flat sheets, or of alternating layers of both kinds of material, &c." "*Similar rocks when they come to the surface by 'massive eruptions,'* do not present these distinguishing features. They usually compose ranges of small width in proportion to their length, and in place of one or more distinct centres, an elongated axis may be detected." They present "a certain *massive* character." "'Masses' are frequently found thousands of feet in height, which do not vary perceptibly in character, and show no horizontal structure." The "breccias," which sometimes accompany them in very large masses, "do not *often* occur in stratified layers." "The ranges show no signs of craters—*yet they are frequently the foundations of Volcanos. Oftener still* do Volcanos occur on the lower portions of their slopes, or in a series parallel to the axis of the main range, and even greatly exceed it in elevation. Notwithstanding these points of difference, it is often difficult to decide what was the mode of origin of an accumulation of volcanic rocks" (p. 61).

Well may this be, since the points of difference are certainly quite undistinguishable. It is evident that we have here the old error of the school of Humboldt, which refuses to acknowledge any mountain mass to have been a volcano, though composed wholly of volcanic rocks, which has not an evident "opening" or crater at its summit, or at least a conical form, or small radiating streams of lava; nay, even in the case of these, attributes the formation of the cone and crater to 'upheaval,' not to successive eruptions from the same vent. Thus, among other passages in his Cosmos, Humboldt, says (p. 224 Sabine's Translation, Ed. 1858) :—

"We may ascribe to a *first fissuring* of the deeply disturbed earth-crust, the oldest formation of erupted rocks (*often perfectly similar in mineral composition to recent lavas*); then these fissures, *as well as the 'craters of elevation' of later origin*, must be looked upon only as volcanic openings *through which erupted masses* have flowed, *and not as 'volcanos proper.'* The principal characteristic of these latter consists in a permanent, or at least from time to time renewed, connection between the deep-seated focus, or source of igneous action, and the atmosphere." "The Volcano requires for this purpose a particular kind of framework. Therefore its form-giving or shaping activity is exerted in the *upheaval of the ground*; *not* (as was formerly believed) *in the building up by successive accumulation* of scoriæ and strata of lava deposited one above another." In a subsequent passage, referring to the great volcanic development of Western America, he suggests how much remains to be done there by "a competent Geologist who should devote himself to the mineralogical determination of its trachytes, dolerites, and melaphyres, and to the *discrimination of the originally upheaved mass* from the part that has been covered by subsequent eruptions." "Conical or dome or bell-shaped mountains which have never been opened, are to be most carefully distinguished from volcanos, which *either now emit*, or *have at any former period emitted*, scoriæ and lava, like Vesuvius and Etna, or scoriæ and ashes only, like Pichinca and Cotopaxi" (p. 267, *id.*).

It is evident that M. Richthofen has acted on this hint; and hence his grand two-fold division of volcanic rocks, into "massive eruptions," and the products of "volcanos proper."

It is really time, however, that all these fanciful ideas should be renounced. It is utterly impossible, whether in the writings of these and other Geologists of this school, or in nature, to find any intelligible distinction between volcanic rocks that have issued from fissures, so as to form "massive," or "elongated," or "dome-shaped" mountains, and rocks produced by eruptions from "volcanos proper." It is a miserable thing that such untenable distinctions, couched as they are in vague and confused language indicative of a corresponding confusion of ideas, should be taught generally in Mining-schools on the Continent, and, we fear, some of this country also, where Humboldt's Cosmos is still a classical school-book. If these remarks should be considered too strong, let it be remembered that this confusion of ideas as to the origin of volcanic rocks, is not confined to a single passage or two of the Cosmos, but pervades the whole of the 350 pages of that work, which treat of "volcanos" (three-fourths of the whole), and that the same unfortunate misconception has gone far to destroy the benefit that might have accrued to science from the researches of an entire generation of both German and French Geologists in volcanic regions, had not their interpretation of the facts before their eyes been blinded by the influence of so great a name. I cannot hesitate to express the opinion that until these vague and contradictory views of the character of volcanic action are universally renounced, no progress can be made towards a sound theory of the mode of production of the class of Hypogene formations, from Obsidian and Pumice to Granite itself.

That the vast accumulations of Trachytic porphyry, and also of basalt, which accompany and envelop the now or recently active volcanic cones of Western America (as of Hungary and many other localities) have sometimes issued from prolonged fissures, or from so many points upon such fissures, as to combine to form vast elongated 'masses,' while on other points where the eruptive action has been more concentrated, or lasted longer, the lava has accumulated over the vent in domes or cones, sometimes of enormous magnitude, is in entire accordance with the normal action of volcanic energy. Why then are the volcanic rocks that have assumed these "massive" forms not to be called "the product of volcanos?" Such a distinction cannot rest (as some might imagine) on the absence among them of fragmentary ejecta, thrown up by explosive outbursts of vapour from a volcanic vent, for M. Richthofen himself, no less than Humboldt, declares that in America the amount of pumice, ash, tuffs, and breccias, that form part of his "massive eruptions," probably equals that of the more solid rocks. The emission of these "massive eruptions" must then have been accompanied generally by explosive aeriform discharges from some neighbouring vent or vents. Where then, again I ask, is the distinction of such phenomena from those of "volcanos proper?" This is not a mere dispute about words. The school in question maintains that the vast accumulations of trachyte greystone and basalt met with in countries admittedly volcanic, were "not produced by volcanos," but in some non-descript manner; and that "volcanos proper" are merely portions of these previously existing rocks which, at some comparatively recent period, have been upheaved bladder-fashion, and in some cases pierced with a hole which has allowed the escape of vapour from beneath, throwing up and sprinkling around ashes and some minor dribblings of lava. Such a theory of volcanic action I maintain to be demonstrably false; and that, on the contrary, all volcanic formations were produced by volcanic action such as we see it in the present day, fracturing the surface of the earth by earthquake shocks; extruding through the fissures so formed, on one or more points of them, lavas more or less liquid, which accumulate round the vent; expelling, in explosive jets of vapour, fragmentary lava or broken pieces of the rocks through which they have forced their way, and sometimes blowing up into the air, by a series of such explosions, the whole mountain which had resulted from preceding eruptions, and scattering its substance in layers of ash or breccia over vast areas of sea and land around.

Though it has been over and over again demonstrated, and is admitted by Humboldt, that rocks, the volcanic origin of which is unquestionable, exhibiting great varieties of mineral character from the most highly felspathic Trachyte to the densest Augitic Basalt, are occasionally found alternating with one another without any definite order,[1] it is true that in the greater number of volcanic groups the more felspathic rocks are found chiefly in the vicinity of the central points of eruption, and in the form of bulky, often dome-shaped, masses; while the basaltic currents have extended to greater distances, and affect the form rather of comparatively shallow and spreading sheets:—this difference being no doubt due to the generally superior fluidity and greater specific gravity of the latter, at the time of their emission as lava from the volcano. A close study of the volcanic rocks of central France, made in 1821, convinced me that the bulky—indeed mountainous—trachytic bosses of the Puy de Dome, Mont Dore, Cantal, and Mezen, having a vertical thickness of from a hundred to more than 2,000 feet, owed this "massiveness" to the great consistency, and consequently sluggish movement, of the matter, when protruded in a spongy, porous, intumescent state, from the eruptive vents. Where the slopes were considerable, this trachytic lava had spread in thick beds over the contiguous surfaces. Where these were less inclined, or nearly level, it had accumulated in colossal "domes" over the orifice; as, for example, in the case of the Puy de Dome, a haycock-shaped mass of porous trachyte, nearly 2,000 feet in height above its base, which, as well as four or five other similar hills of lesser magnitude, is seen to rise out of a crater within one of the recent cinder-cones of the "chain of Puys." In the volume on Volcanic Phenomena which I published in 1825, I attributed this peculiarity of many trachytic lavas to the fact that they did not issue from the volcanic vent in a state of dry igneous fusion, like that of glass or metal melted in a furnace, but as a heated granular or semi-crystalline paste or magma, to which the elastic tension of minute particles of water (or steam) contained in the interstices of their imperfect crystals gave a spongy tumefaction and partial liquidity; while the escape of this steam from the exposed surfaces, through their numerous pores, occasioned the rapid consolidation of the extruded mass. These views of the varying, but always imperfect, liquidity of lavas at the period of their eruption, and the agency of water in its production, were disregarded at the time by geologists, and have not even yet obtained complete recognition, in spite of their confirmation by the experiments of Daubrée, and the microscopical observations of Mr. Sorby. Even in standard works of such authority as Lyell's Elements, the old doctrine is still taught of the complete igneous fusion of all lavas, and the derivation of their crystalline texture entirely from more or less "slow cooling" *after*

[1] Volcanos, ed. 1862, p. 128, *et seq.*

their emission.[1] How inconsistent this idea is with the highly crystalline—indeed granitoidal—texture of many trachytes, greystones, and basalts, even up to the very surface of the lava-streams, while other lava rocks retain a glassy texture throughout, I have shewn in another place;[2] and until these views are recognized, and brought to explain the mode of production of the entire series of hypogene rocks, no sound progress will, I believe, be made in this most important branch of geology. That portion of the series which usually goes by the name of the "plutonic" rocks, viz., the granites, syenites, older porphyries, greenstones, and Serpentines, owe perhaps their distinguishing characters, and the absence of any accompanying fragmentary ejecta, to their consolidation and cooling under greater pressure at the bottom of deep seas, or at considerable depths within the solid external crust; by which the expansion and escape of the contained water was prevented, and consequently those sub-aërial explosions, which alone could give rise to the formation of ash, pumice-tuff, or scoriæ breccias. I think it improbable that vesicular cavities, at least of any considerable magnitude, such as those which characterize pumice or scoriæ, could be produced under any pressure much exceeding that of the atmosphere. But even in the case of these plutonic rocks, there is ample proof in the aspect and interlacing of the several minerals composing them, especially in the manner in which the least fusible mineral, quartz, has moulded itself upon the more fusible felspar, hornblende, garnet, etc., that the condition of their matter previous to its ultimate consolidation was of the nature of what M. Daubrée calls "aqueous fusion," rather than of dry igneous fusion. In point of age there is no good reason for denying that rocks of this character may be even now in process of formation under the surface,—that is, of alteration by the varying agencies of heat, pressure, internal movements, and chemical reactions. But of the more specially volcanic rocks—such, namely, as by their position, and the accompaniments of ash, tuffs, pumiceous, or scoriaceoüs breccias, rather than by their mineral composition alone, shew themselves to have been erupted as lavas of greater or less consistency, from volcanic subaërial vents, or in moderately shallow water,—there can be no doubt that from the very commencement of the Laurentian era of sedimentary deposition, such eruptions have been taking place on numerous points on the surface of the globe,—generally in great linear bands attesting prolonged fissures in the crust, which exhibit a remarkable parallelism on the whole to the neighbouring elevated ranges of sedimentary strata, crystalline schists, and plutonic axial outbursts, a significant coincidence of direction not without a cause.[3]

To return for a moment to M. Richthofen. It is sad to think of the opportunity for extending our knowledge of volcanic formations and phenomena which lay at his disposal during his residence in California, if he had made good use of it by a painstaking examination and accurate description of those which fell under his observation, instead of rushing into print with a crude classification of rocks founded on imperfect data, and an ambitious Cosmical theory, the ideas of which are culled from the works of other geologists, not often referred to, with which the remainder of his memoir is filled. No doubt the earlier manifestations of volcanic energy along the entire north-west coast-range of the two Americas would amply repay an accurate and close examination, undertaken on separate points by competent geologists.

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[1] Lyell's Elements, ed. 1865, p. 596.

[2] See Volcanos, p. 130.

[3] See Volcanos, p. 476.

Mr. Darwin,[1] long since reported, as the result of his examination of a section across the South American Continent, that the geographical area east of the Andes, must have once consisted of metamorphic schists, clay-slates, and plutonic rocks, forming the floor of the ocean, which were then covered by vast streams of lava (trachytic, and greenstone porphyries), together with alternating piles of angular fragments of similar rocks—all ejected from *submarine volcanos*, and apparently, from the compactness of the rocks, so formed in deep water. This volcanic formation was subsequently covered by gypseous deposits of the age of our Chalk, mingled with the products of contemporaneous *volcanic eruptions*. And in some points, especially in Chili, these beds were again loaded, in the latter Tertiary period, with a vast pile of volcanic submarine tuffs and lavas, previous to the final elevation of the continent above the water level, or the opening of the great sub-aërial volcanic range of the existing Cordilleras.

Surely this is a far more intelligible account of the relations between the several hypogene and sedimentary rocks of America than can be gathered from the confused and inconsistent statements of MM. Humboldt, Dollfus, or Richthofen. Let us hope that some painstaking geologist like Mr. Darwin, with a judgment unwarped by prepossessions in favour of the absurd elevation-crater theory, will, before long, extend his observations to other portions of the great western Continent, and communicate to the public his detailed description of these interesting relations.[2]

G. P. Scrope.

II.—Revue de Géologie, pour les années 1866 et 1867. Par MM. Delesse et De Lapparent. Paris, 1869.

With each succeeding year the progress of Geology, like other sciences, naturally accumulates so many new facts and observations, and these are distributed through so many periodicals, and in different languages, that it is very difficult for the student to keep himself fully acquainted with the increased knowledge or continued additions to the science. A useful *resumé*, like the work before us, is therefore very acceptable, especially when the materials are carefully collated and judiciously arranged. The "Revue de Géologie," under the able editorship of MM. Delesse et De Lapparent, which now extends to six volumes, must always be a valuable addition to the library of the geologist, inasmuch as it not only gives abstracts of the more important papers, but also references to the periodicals in which they appear. The present volume comprises the report of the principal works which have been published for the years 1866–67, besides which it contains some unpublished papers which have been communicated directly to the Editors, as well as an account of the mineral substances in the French Exposition of 1867, capable of being usefully employed. The subjects are treated in a similar manner to that adopted in the preceding volume, under four heads—Preliminary Observations, Rocks, Strata, Terrans, and Geological Descriptions. The first part includes notices of the general works on geology, the agencies at present in operation, as atmospheric, glacial, lacustrine, and marine, followed by articles on subterranean and mineral waters, oscillation of coasts and volcanic phenomena, and the connection between mineral springs and the deposits of petroleum with the dislocations of strata. The most productive oil region of eastern Virginia is comprised in a zone of elevation which extends from the burning springs to the Ohio, a distance of nearly sixty kilometres. The second part treats of lithology, including the general properties, and the classification of rocks, followed by special notices on the composition of the rocks themselves. This part occupies more than one hundred pages of the volume, including the Carbonaceous, Calcareous, Siliceous, Argillaceous, Magnesian, Felspathic, and Metalliferous rocks of different countries; together with the formation of minerals, rocks, and stony cements, and also the modifications which rocks have undergone by special and general metamorphism. Among these articles we notice the analysis of the principal marbles of the Jura, by C. Méne, the most remarkable of which is that of Crans, distinguished by its fine yellow colour, interspersed with parallel veins and knots resembling ash wood. Other remarkable marbles, briefly alluded to here, but more fully treated of in M. Delesse's interesting work on the materials for construction in the Universal Exposition of 1867, are those of Italy, Greece, Livonia, Portugal, Silesia, Westphalia, Spain, Austria, Canada, and the United States. The third part contains the classification of the stratified rocks and their fossils of different countries, arranged in chronological order. This includes references to a series of memoirs of great use to the geologist, followed as it is by references to some special palæontological papers. The last part comprises geological descriptions of different countries, either containing notices of special local geology, or memoirs on general geology, amongst which may be mentioned the studies of MM. Boisse and Vène on the geology of the departments of Aveyron and the Ande, as well as some notes by M. de Mortillet on Italian geology, by M. Dewalque on Belgium, by M. L. Ville on Algeria, and M. Garnier on New Caledonia; besides which, as in preceding years, the principal sinkings or borings are described in detail which have been communicated by MM. Dru, Laurent, and Degoussé. Containing, as this volume does, so much valuable information and useful references, we cannot doubt that it will be an acceptable work to all who take an interest in the progress of geology, and by whom we hope it will be favourably received and consulted, as an encouragement to the authors to continue their laborious researches. J. M.

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[1] Darwin's S. America, p. 237.

[2] Such a description will probably be in part found (by those who have the opportunity of consulting it) in the report of Dr. J. S. Newberry to Congress, published 1861, of his geological observations while employed on the expedition for exploration of the Rio Colorado, in 1857-8, of which I find a notice in page xlii. of Mr. Bell's "New Tracks in North America," just published by Messrs. Chapman and Hall.

III.—NOTES ON THE GEOLOGY OF NORTH SHROPSHIRE. By CHARLOTTE EYTON. London. 12mo. pp. 88. Robert Hardwicke, 1869.

MISS EYTON has produced a small, but very nice little book, on the Geology of that part of her native county with which she is most intimate, namely the neighbourhood of the Wrekin, and part of the plain of North Shropshire.

The district embraces Igneous and Metamorphic rocks of various ages, the Cambrian rocks, the Silurian—both Upper and Lower—the Carboniferous series, the Bunter Sandstone, the Trias, and, scattered here and there, Glacial Drifts and other superficial deposits.

"The change," writes Miss Eyton, "from the Silurian scenery on the south bank of the Severn to that of the New Red Sandstone on the north, is very remarkable and characteristic. The ever-varying outlines, the peaks and ridges, the ravines and glens of the former, stand in striking contrast to the level plain, rarely diversified by an outbreak of Igneous rock, which marks the extent of the latter. And yet it is the same influence, acting upon a different surface, that has produced both. The denuding agent (supposing it to act evenly over the whole extent) which, working upon alternate beds of hard and soft rock, forms corresponding alternations of ridge and furrow, will, when moving over an uniform surface, presenting no weak points and everywhere equally susceptible to its influence, produce the effect of a perfectly level plain, removing the same proportion of substance in every part, and smoothing and rounding all inequalities that may previously have existed. The only agent which we know of that does act thus evenly is the sea. The effect of atmospheric denudation is generally to cause uneven depressions and furrows. Some of these exist in the plain now under consideration, but they are not of sufficient importance to break the general effect of the outline above described." (p. 11.)

In referring to the Coal Plants Miss Eyton laments that we do not possess any good work on the subject since Lindley and Hutton. She will be glad to learn that Mr. Carruthers, who has already so much increased our knowledge of fossil plants, contemplates the publication of a complete British Fossil Flora. In speaking of Mr. Binney's discovery of the connection between *Stigmariæ* (the roots) and *Sigillariæ* (the stems) found in the Coal-measures (p. 41, line 9 from foot of page), Miss Eyton has inadvertently spoken of the *former* as being found *upright*, instead of horizontal, in the underclay.

We do not think the theory of "an *island*, comprehending the

Coal-fields of South Staffordshire, Coalbrook-dale, and the south-west of Shropshire," upon which "the Coal-measures were formed, each seam representing the growth and decay of a tropical forest" (p. 43), is quite tenable; on the contrary we believe it to be more probable that the Coal-beds were formed in a wide river-valley, subject to tidal overflows, and thus affording that admixture of marine and freshwater conditions which the fauna and flora of the Coal-measures indicate.

Miss Eyton has devoted considerable time and attention to the later deposits, as well as to the more regular and older rock-formations. Thus we find chapters on the Glacial and Marine Drifts—the Lake and Forest period. The changes of the surface resulting from atmospheric denudation, and the alterations in the relative level of the sea and land, have also been carefully studied by the authoress. We are much interested by Miss Eyton's book, and recommend it to all who wish to know something of the Geology of North Shropshire.

IV.—THE GEOLOGY AND MINERAL VEINS OF THE COUNTRY AROUND SHELVE, SHROPSHIRE, WITH A NOTICE OF THE BREIDDEN HILLS. By G. H. MORTON, F.G.S., F.R.G.S.I., President of the Liverpool Geological Society. (Extracted from the Proceedings of the Society, 1868–9.) Liverpool. 8vo. pp. 41.

IN this article we are introduced to a remote, and but little known district in Western Shropshire, once a part of the ancient kingdom of the Silures, from which the name to the far wider "Silurian System" was derived, and where the Lower Silurian (Llandeilo) series is prominently developed.

This locality is not only interesting to the geologist and palæontologist, but the antiquary and historian may here also examine numerous Druidical circles, ancient encampments, and barrows, with Roman remains of various kinds, including traces of extensive lead-mines on Shelve-hill marked by pottery, coins, oaken spades, and Roman pigs of lead (preserved in the Liverpool and British Museums), and bearing the name of the Emperor Hadrian.

Mr. Morton mentions the discovery of ancient smelting-places, some of which are probably Roman. The author gives several geological sections in order to show the relation of the eruptive Greenstone of Corndon Hill to the Lingula Flags, Llandeilo beds, Cambrians, etc., which have been elevated by it, or which rest upon its flanks. Lists of the fossils which mark the Upper and Lower Llandeilo, the Upper Llandovery rocks, etc., are also given. Mr. Morton likewise describes and maps the mineral veins, showing their compass-bearings and the various minerals they have yielded. The author concludes with a brief sketch of the Breidden Hills.

V.—BURTON-ON-TRENT: ITS HISTORY, ITS WATERS, AND ITS BREWERIES. By WILLIAM MOLYNEUX, F.G.S. London, 1869. 8vo. pp. 268. Trübner & Co.

MR. MOLYNEUX has produced, for the convenience of all who wish to be informed thereon, a very useful book of reference concerning Burton-on-Trent, prepared with much care, and embracing its history from the earliest times, as marked by flint-implements in its river-valley gravels, by tumuli and barrows, by Roman roads, cinerary urns, etc., down to the commencement of Ecclesiastical history in the ninth century. Through the leading details of this Mr. Molyneux conducts us. We learn both from the dedication and contents of the book, that the history of Burton-on-Trent is closely connected with the family of Paget; and when we reach the year 1815, we are reminded of the share which the noble Marquess of Anglesey took in the eventful history of that time which culminated in the field of Waterloo.

The geological part of Mr. Molyneux's book commences at p. 147, and deals principally with the relation between the geology of the district and its water supply, upon the goodness and quantity of which the staple article of manufacture of the town (bitter beer) so greatly depends. The valley of the Trent, in which the town of Burton stands, is excavated in the Keuper marls, sandstones, and Bunter conglomerates, here much faulted and disturbed; above these are beds of coarse gravel, sand, and pebbles, old terrace-gravels, modern valley-gravels, and alluvial deposits, entirely concealing the older beds which lie beneath.

All the old wells of Burton are sunk in the ordinary valley-gravels, and until 1856 none of these wells exceeded twenty feet in depth, and neither the thickness of the gravels nor the nature of the strata upon which they rested had been ascertained. As the breweries increased in importance, however, numerous deep borings were executed by Messrs. Bass and Co., Ind, Coope, and Co., Allsopp and Sons, and Salt and Co., with varied success—as regards the supply of water yielded—depending apparently upon the point selected for the well; as it has been found that, owing to faults, scarcely any two deep wells yield a like supply. The waters derived from the river, the shallow wells, and the deep artesian borings, contain not only different chemical products, but in very varied proportions.

No less than seven different kinds of waters, used in connection with the breweries of Burton, have been recognized, each of which —with one exception—is derived from different distinct deposits of local occurrence. These are—Bunter conglomerates, Keuper marls and sandstones, Valley-gravels, and from two separate old river-valley deposits, and lastly from the river Trent. Two only of these, however, have hitherto been used for brewing purposes.

The question may very naturally be asked, why has the manufacture of ale at Burton attained such marked success over that of any other town? Mr. Molyneux informs us that this generally recognized superiority is attributable to a certain chemical property possessed by the waters used in its production. This property consists of sulphate of lime, and is derived from the gypseous deposits contained in the Keuper marls of the district.

It appears that the average amount of Gypsum derived from the water used in brewing 1,000 barrels of ale equals 250 pounds weight. "Assuming, therefore, by way of illustration, that Burton produces annually 1,400,000 barrels of ale, no less than 350,000 pounds of this mineral are raised from the valley-gravels, and assist in the manufacture of that quantity of ale or bitter beer, and are, with those beverages, imbibed at different points in the four quarters of the earth." (p. 208).

The time is probably not far distant when, by careful chemical admixture of sulphate of lime or other ingredients in proper proportions, the water of any district may be made to brew equally good ale to that of Burton-on-Trent.

Meantime let us thank Mr. Molyneux for his useful book, and drink Burton ale until we can find out a way to brew better from the regenerated Thames and the waters of the London basin. Mr. Molyneux gives a good deal of information about the geology of the country around Burton, with reliable sections and lists of fossils from the Coal-measures, etc.

REPORTS AND PROCEEDINGS.

GEOLOGICAL AND NATURAL HISTORY FIELD-CLUB FOR BOURNEMOUTH.—We are glad to be able to record in our pages the formation of another Field-naturalists' club. A Bournemouth newspaper informs us that on the 24th of September a meeting was held at the Assembly-rooms to hear a lecture by W. Stephen Mitchell, Esq., on the Geology and Leaf-beds of the neighbourhood, and to consider the suggestion of the formation of a local club. Rear-Admiral Sir J. B. Sulivan, K.C.B., was announced to take the chair, but being called away to Portsmouth, Captain Haggard presided. The meeting was very numerously attended, and a list of distinguished residents reported in the paper as present shows that the club starts under favourable auspices. Mr. Mitchell solicited the loan of specimens from various gentlemen, and we see that Sir J. Sulivan, Rev. A. M. Bennet, Rev. T. H. Wanklyn, Captain Haggard, E. J. Sanders, Esq., E. Kemp-Welch, Esq., contributed fossil leaves from various localities, and Barton, Purbeck, and Portland fossils; flint implements from Bournemouth. These were, with the assistance of Captain Creek, Mr. Sulivan, and Mr. Kemp-Welch, arranged in cases in the room. At the close of the lecture the Rev. H. B. Clissold proposed that a club be formed, and a number of gentlemen adjourned to a private room, where some club-rules, which had been suggested and circulated by the lecturer, were discussed. An adjourned meeting has since been held, and Sir. J. B. Sulivan, K.C.B., has been elected President. Sir James was Lieutenant in H.M. ship "Beagle," when Fitzroy was Captain and Charles Darwin was Naturalist on board. We wish the club all success. There is plenty of work in their neighbourhood for them to do.

EXPLORATION OF THE LEAF-BED OF THE LOWER BAGSHOT SERIES OF THE HAMPSHIRE BASIN.—The following are the suggestions which have been issued by the Committee appointed by the British Association for the Advancement of Science to investigate the fossil leaf-beds of the Lower Bagshot series of the Hampshire Basin. The Committee consists of W. Stephen Mitchell, LL.B., F.G.S. (Sec.); Professor J. Morris, F.G.S., University College, London; George Maw, Esq., F.L.S., F.G.S.; Robert Etheridge, Esq., F.R.S.E., F.G.S., Royal School of Mines, Jermyn Street; Henry Woodward, Esq., F.G.S., F.Z.S., British Museum:—

The Committee desire to obtain the co-operation of gentlemen interested in local geology who reside in the districts of Hampshire and Dorset, over which the Lower Bagshot beds extend.

They will be glad to receive information of the occurrence of fossil leaves, however fragmentary, from any new localities, *e.g.*, the neighbourhoods of Romsey, Fordingbridge, Moreton, Wimborne, Whitecliff Bay, etc.

In the neighbourhoods of Bournemouth, Corfe, Studland, and Alum Bay, etc., where they have already received valuable assistance, they desire if possible to establish more systematic records. As some guide to the kind of information wanted, they beg to invite attention to the following suggestions:—

The changing face of the cliffs near Bournemouth after storms and heavy rains, and the extensive clay-workings in the Wareham district, where the beds can be examined yard by yard, often present data of importance which, unless observed and recorded at the time, may be for ever lost. It is only by residents that these observations can be systematically made.

It is very desirable that records of the following should be preserved:—

1. The occurrence of trunks or branches of trees.
   (*a*) Their locality. The bed in which they are found, and the relation of the beds above and below.
   (This will be best recorded by a sketch of the section.)
   (*b*) Their condition, position (horizontal or otherwise, and direction (with reference to the compass).
   (*c*) Their size. Whether bored by *Teredo* or not. Character, size, direction, and position of the borings.
   (*d*) Sections for microscope where possible.
2. The beds containing leaves.
   (*a*) Their number, thickness, and extent, and the directions in which they vary in thickness.
   (*b*) The condition of the leaves, whether perfect, as if tranquilly deposited, or rolled and broken, as if water-borne from a distance.
   (*c*) Flowers, fruits, seeds, and the fructification of ferns.

3. **The beds of sand interstratified with beds of clay.**
   - (*a*) **Their number, thickness, and extent, and the directions in which they vary in thickness.**
   - (*b*) **Presence of pebbles and grains of quartz. Their size; rounded or angular; free or cemented together.**
4. **The occurrence of "re-formed" beds containing fragments of clay enclosing leaves. Whether these beds are confined to mouths of chines.**
5. **Varying thickness of the pebble bed and gravel beds on the surface.**
6. **Shells and insects have as yet been found only at Studland. A further collection, with note of exact locality, would be very valuable.**

It is requested that letters be directed to W. Stephen Mitchell, Esq., Caius College, Cambridge, and specimens (which should be separately wrapped in soft paper and firmly packed in hay or crumpled paper) to Henry Woodward, Esq., British Museum, W.C.

It is hoped that arrangements will soon be completed in Bournemouth for a public local collection.

CORRESPONDENCE.

MEGACEROS HIBERNICUS, THE GIGANTIC IRISH DEER.

SIR.—It may interest some of your readers to learn that I have a very fine pair of horns, with skull attached, of the gigantic Irish deer (*Megaceros Hibernicus*), found in the bog of Schiule, Co. Limerick, at the depth of about 16 feet. The measurement of the horns is as follows:—Tip to tip, 12 feet 8 inches; round the curve, 14 feet 5 inches; breadth of palm,[1] 4 feet 6 inches (?). Should any museum require a fine head of this deer, I shall be glad to send further particulars.

ROBERT COX.

BALLYNEALE, BALLINGARRY, CO. LIMERICK.

SIR,—Please publish the following:—William Hinchley, Carpenter, Thomond's Gate, Limerick, has a good specimen of a head of a female *Megaceros* to sell. These are rather rare and hard to get, as they are so like horses' heads that few people who find them put any value upon them.

G. H. K.

CONNEMARA.

ON THE FORMATION OF THE CHESIL BANK.

SIR,—In a paper under this heading in your number for October, Mr. Bristow and Mr. Whitaker quote from my book "Rain and Rivers." I have said that Portland was probably at one time made an island by the erosion of the sea, and that it was afterwards re-joined to England by the rising of the land. Mr. Whitaker tells us of a raised beach on Portland "thirty or forty feet above the sea." Is not this proof positive of the correctness of my theory? Did Portland rise thirty or forty feet and the isthmus remain stationary? This junction with the land made Portland a groin protruding at right angles with the line of coast; and I have headed a passage (page 119 "Rain and Rivers") "Portland is *a natural groin* which catches the Chesil beach." I have also said that to any one conversant with the laws of the groin the mysteries of the Chesil beach vanish. Mr. Whitaker adopts the term "natural groyne" as his own. He also adopts the theory as his own, and says of it "that of course all must agree" to it. I have never happened to see Portland called a "natural groin;" nor have I seen the phenomena of the Chesil beach explained as those of a beach collected and formed by a groin. If Mr. Whitaker has, perhaps he will tell us where and by whom this has been published. Be this as it may, I would wish to say a word as to the heaping of the beach which is formed by the "natural groin." Mr. Whitaker avoids the question; but he mentions "the set of the current" from west to east three times. The shingle he thinks is carried by this current, since, page 435, the shingle is "stopped in its easterly course," and in page 436 he seems to form the shingle beach by "the general set of the current." Lyell, as quoted by Mr. Whitaker, attributes the heaping to "meeting of tides," "a great eddy," "the tidal wave," and "the set of the tide in the narrow channel." While Herschel (Physical Geography, second edition, page 91) makes "tide currents" deposit "the great shingle drift of Dungeness Point and the Chesil Bank."

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[1] ? Circumference.—EDIT.

Let us, for argument, grant Mr. Whitaker's *assumed* current from west to east along our south coast, and let this current be of force sufficient to drive pebbles of the size of those at the Portland end of the Chesil beach, they would at least travel along the bottom of the current. But even if they floated on the top of the current how could they get to the top of the beach which is forty-two feet above the level of the water? So if Lyell's and Herschel's tide had "eddied" here, it must have flowed as high as the top of the beach, and even then it must have carried the pebbles on its surface to have placed them where they are. These philosophers would be the first to remind us of the rule that water can only find one level, and that it cannot rise above its source; and this rule entirely precludes the possibility of the beach being heaped by tides or currents. But rules are apt to have exceptions, and the exception here is that when impact is given to water it will rise itself, and it will raise other substances very much higher than its source. In art we see this in the ram which sends water to the top of the house, though the ram and the source of the water may be much lower than the foundation of the house. In nature we see the exception in the effects of the impact given to the wave by the wind. It is then not tides or currents of water, but currents of air giving impact to the waves which have driven the drift to the top of the beach. Drayton gives this vera causa in 1613, "by the south wind raysd." One great law of the sea-shore is, as the wind blows the wave flows, and as the wave flows the beach goes. It is the prevalence of south-west winds in the northern hemisphere which runs beaches across the mouths of so many of our south-coast streams, great and small; and it is a law on the south-coast (quoted in a note by Mr. Whitaker himself) that where a travelling beach comes across an estuary the water escapes by soaking through the beach (the frequent cause of the *so-called* submerged forest) or by forcing a passage to the east. Notwithstanding this *law* Mr. Whitaker starts his theory of the escape of the Fleet-water eastward as new, and he considers the shingle of the Chesil beach to be in an "*anomalous* position," his reason for calling it "anomalous" being that the beach is *longer* than other beaches, and that on the land side "there is no river emptying into the sea, but only a succession of very small streams." But is not a succession of small streams, flowing by one channel into the sea, "a river emptying into the sea?" If Smallmouth sands were raised to the height of the Chesil beach, both being impervious, the Fleet would be a freshwater lake at that height. It would, however, quickly cut an outlet, and form an estuary at the present depth, and the land side of the estuary would of course be denuded as now by rain and rivers like the sides of every other estuary.

I must not ask for your valuable space to enter farther into the laws of the sea-shore, to describe the cause of the so-called "submerged forest," the principles of that most ingenious device the groin, or to explain the cause of the sorting and sizing of the materials of the Chesil beach. These materials decrease most gradually for twenty miles, that is, from the large pebbles at Portland to the pure blown sand at Bridport. These things are detailed in the eighth chapter of "Rain and Rivers," which is headed "Travelling of Sea-beach," a subject on which profound ignorance prevails.

George Greenwood, Colonel.

Brookwood Park, Alresford,
4th of October, 1869.

DISCOVERY OF ARCTIC SHELLS BELOW BOULDER-CLAY, AT WOODHILL, KILMAURS.

Sir,—In making some observations on the Boulder-clay, in the Kilmarnock district, in the end of Autumn, 1868, I was fortunate in finding a few Arctic shells from a bed of sand lying below the Boulder-clay at Woodhill, Kilmaurs. The shells are now in the Hunterian Museum, Glasgow, and, as recognized by Mr. John Young, the Curator, are *Leda oblonga, Tellina calcarea, Pecten Islandica, Cyprina Islandica, Astarte sulcata, A. compressa, Natica Grœnlandica*, and fragments of a large species of *Natica*, and a *Littorina*. They were got in sinking a pit scarcely half-a-mile from the old quarry, where so many elephants' tusks and deer horns were found. The section stands thus—Boulder-clay, fifty-one feet; sand, with marine shells (the above), one foot three inches; peaty clay, mixed with sand, one foot six inches (this is the bed in which the tusks and horns were found); run, or cemented, gravelly sand, one district, and went to considerable expense in getting them properly foot six inches, lying upon the Carboniferous strata. Farther researches this summer have fully confirmed my first impression, that the shell-bed lies below the lower Boulder-clay. The country around Kilmarnock is largely perforated with pits, and good opportunity is afforded for observing the surface-beds. In none of these pits has Boulder-clay been found underlying the sand and peaty beds. The sand bed is very irregularly developed, being as thick as thirty feet in one pit, and in others ten feet, twenty feet, and so on. The peaty bed is apparently the remains of an older bed, most likely of estuarine (?) formation, being found in patches, often at considerable distances apart, remnants no doubt of a larger bed that has suffered by denudation. The discovery of these shells throws light upon the former discoveries at Kilmaurs, and gives the true horizon of the bed where the elephants' tusks and horns of the reindeer were found.

R. CRAIG.

LANGSIDE BEITH,
October 7th, 1869.

SIR,—Will you kindly give publicity to a work which is now in progress, viz. Murray's Handbook to the Geology of England and Wales; and allow me to appeal, through the medium of the GEOLOGICAL MAGAZINE, to all brothers of the hammer for assistance and contributions, particularly in local geology, which will be most gratefully acknowledged.

PHILLIPS BEVAN, F.G.S., Editor.

4, SUFFOLK SQUARE, CHELTENHAM, *Oct.* 21, 1869.

OBITUARY.

DR. R. N. RUBIDGE.—We receive from Port Elizabeth the painful intelligence of the sudden death (on the 8th August), of R. N. Rubidge, Esq., M.B. Lond., F.G.S., etc., who was well-known as an enthusiastic labourer in the geology of South Africa. Beginning his medical studies under Dr. John Atherstone, of Port Elizabeth, his habit of accurate observation was acquired and fostered in company with his fellow pupil and friend, Dr. W. G. Atherstone, of that town, also known as an ardent and successful geological explorer of South Africa, sometime in company with the late Mr. A. G. Bain, who first worked out and mapped the geology of that region.

In 1854 Dr. Rubidge was requested by the merchants of Port Elizabeth to visit and report upon the newly discovered gold-diggings near Smithfield, in the Orange River Sovereignty. In company with Mr. Paterson he made a careful examination of the spot, and found that gold in small quantities was associated with quartz in the meridional set of trap-dykes there intersecting the Dicynodon or Karoo beds. In his clear and concise communication of these results to the Geological Society of London (Quart. Journ., vol. xi., p. 1, etc.), Dr. Rubidge mentions a fact that may be of interest in connection with the possible origin of the diamonds that have of late been so profusely found in Orange River territories, namely, that in the eastern ranges of the Stormberg, beyond Aliwal, the anthracitic coal of the Karoo beds has been converted into plumbago by the volcanic dykes. Hence it is possible that, by further change, purer carbon has been elicited from the carbonaceous matter by volcanic or metamorphic agency in the Natal ranges, and has been brought down in the form of *diamond* by the rivers, together with their common agate gravel, derived from the same igneous and often amygdaloidal rocks (see also his letter in the Journ. Geol. Soc., vol. xii., p. 237).

In the same year (1854), at the instance of a Mining Company, Dr. Rubidge went to Namaqualand, to report upon its metal producing capabilities. The results are given by him in the Geological Society's Journ., vol. xiii., a short notice only appearing in the previous volume. The gneissic and schistose rocks of this part of Western Africa being quite new to him, and so full of interesting mineralogical characters, afforded a rich field of observation; and he was particularly struck with the probable metamorphic origin of some granite, and with the apparent silification of some bands of schist, covered unconformably by sandstone, through which water had carried silica to replace the original felspar and mica of the gneissic bands below. This view of the metamorphic condition of some quartzite Dr. Rubidge regarded as a key to the elucidation of certain sections seen in different parts of South Africa, and considered by him to be of a very difficult nature, if left to be explained according to the usual view of geologists. Thus in 1858 (Geol. Soc. Journ., vol. xv., p. 196) he explained the section of Mitchell's Pass, at the village of Ceres, otherwise than Mr. Bain had interpreted it; and regarded the great sandstone formation of Table Mountain as occurring again and again in great patches of horizontal and uncomformable beds, over the highly inclined schists and gneiss, both of the Cape and of Namaqualand, instead of dipping, at Ceres, down below the Devonian rocks of the Bokkeveld; and thus he made the schistose rocks of Cape Town, of the Bokkeveld, George, and southern Uitenhage (whence he got Devonian fossils) to be all of the same date: certainly a great advance was gained in proving the continuation of the Bokkeveld schists into the last-named district; but whether the schists and slates of the Cape come into the same category still requires careful inquiry.

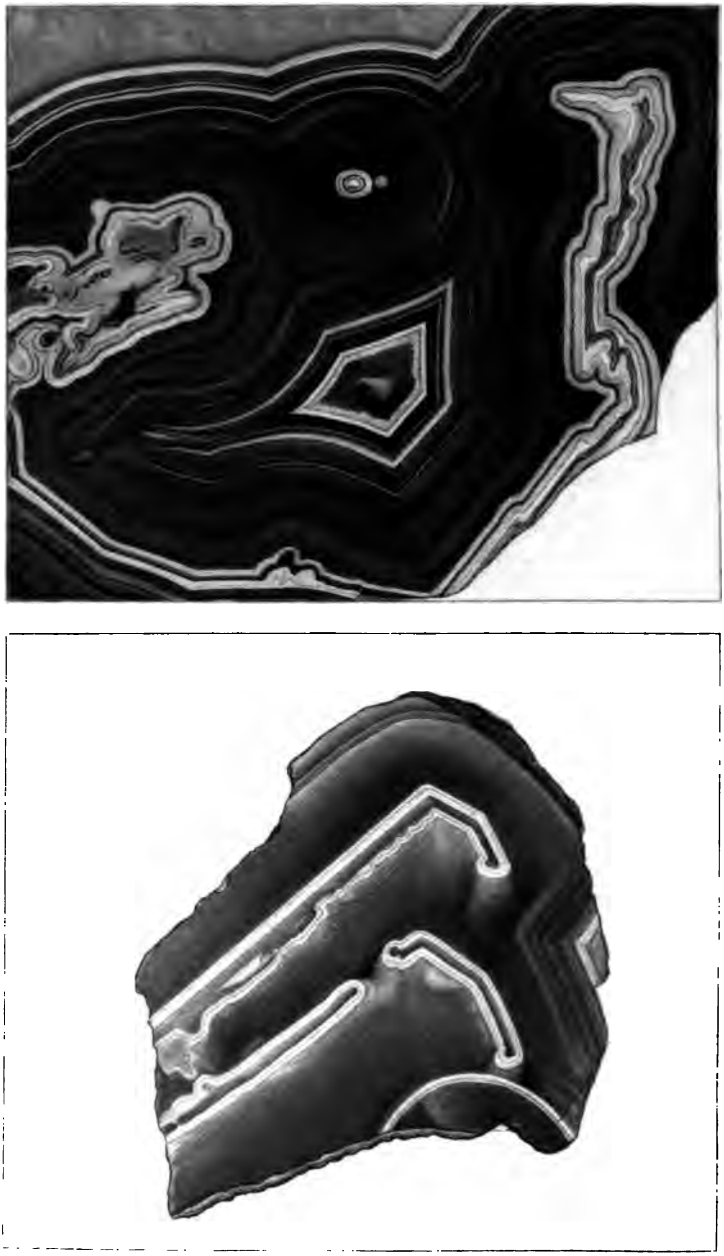
Examining the neighbourhood of the Zuerberg, in occasional journeys, Dr. Rubidge endeavoured to throw light on the stratification and structure of that country, shewing that the Lower Ecca beds are probably of Devonian age. For the illustration of his views on this matter he sent several series of rocks and fossils to the Geological Society of London, and he communicated papers on the subject to that Society, to the "Geologist," to the British Association, and to the periodicals of Port Elizabeth. In 1864 he visited England and travelled to the north with the special view of studying similar schistose and quartzose rocks to those of the Zuerberg. He brought with him many new fossils, of Secondary age, from the Uitenhage examined and determined, intending ultimately to produce a general work on the geology of the colony. The fossils constituted a valuable addition to the South-African collection in the Geological Society's Museum, and were fully described, with illustrations, in the Society's Journal, by Mr. R. Tate, in 1867.

So long ago as 1854, Dr. Rubidge wrote to his geological correspondents in London on the subject of aërial denudation, which had not then received as much attention from European geologists as it deserved. In 1866 he reproduced the chief points of his letters in the GEOLOGICAL MAGAZINE, No. 20, bringing forward evidence of the enormously extensive and long-continued denudation of the interior of South Africa subsequent to its leaving the sea, and since the lacustrine deposits of the Karoo formations were drained dry.

As an observer and as a generalizer, then, Dr. Rubidge was energetic and bold, adding much to the store of geological facts and thought, though working hard throughout in his professional practice, and often suffering from ill-health. Heart-disease has taken him off suddenly (at the age of about forty-eight) from amongst his friends, before his well-loved work was finished as he wished; but he had always given his best attention to the advancement of Science in general, and of Geology in particular, among the community around him; and having always identified himself with the Literary and Scientific Institutions of Port Elizabeth, and shewed the greatest personal interest in its Public Library, Museum, and Public Hospital, his townsmen, who in large numbers of all grades of society attended his funeral, regret him as a kind warm-hearted friend,—a loss which will not be readily replaced. His fellow colonists too in South Africa, and his geological friends in England, are all truly grieved to hear of his death, fully recognizing his amiable qualities, scientific attainments, and devotion to good works.—T. R. J.

MISCELLANEOUS.

MR. MARSHALL HALL'S SCIENTIFIC EXPEDITION.—The schooner yacht *Norna*, Mr. Marshall Hall owner and master, is being laid up at Brightlingsea for the winter, having returned from a Norwegian cruise. She experienced several gales, but has suffered no injury whatever. On passage out, at the same date, one of our largest and finest schooners lost boats and everything above deck. The *Norna* succeeded in penetrating to the furthest extremities of several fjords, where never yacht had been before, and her owner, who is a member of the Alpine Club, has partially explored, and even laid the foundation for a rough survey of, several portions of the large tracts of ice, of which at present but little is known. He proposes to continue his efforts next summer. Mr. Marshall Hall has also made geological investigations of the remarkable terraces very common in the inland valleys of Norway, more especially as regards the time occupied in their formation. Prof. Kjerulf, of Christiania, has also been occupied with this subject.—*Scientific Opinion*, Oct. 6, 1869.



MURAL AGATES

THE
GEOLOGICAL MAGAZINE.

No. LXVI.—DECEMBER, 1869.

ORIGINAL ARTICLES.

I.—Banded and Brecciated Concretions.[1]

By John Ruskin, LL.D., F.G.S.

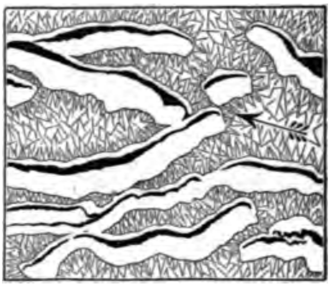
[PLATE XIX.]

WHEN we find at the sides of veins, the veinstone rent into laminæ, as I tried to represent in Plate XX. of Vol. IV. it is easy to think of the fracture as violent, and of the disruption of the vein as sudden.

That, at least, this disruption must have been exceedingly slow, and that as it took place the rent must have been filled by contemporary crystallization, is I think evident in the instances figured, and in the great number of cases which they represent.

And as I continue my inquiry, it becomes more and more questionable to me whether there has in such cases been disruption at all. For the more I endeavour to read Nature patiently, the more I find that she is always trying to deceive us while we are impatient, by pretending to do things in ways in which they never were done, and making things look like one another, which have no connection with each other.

Fig. 1.



For instance, in Fig. 1, which rudely sketches a piece of Cornish hornstone, it would seem at first sight that the detached black and white bands were pieces of a band once continuous, but which had been broken up, and re-cemented in disorder. And if, on a large scale, we had met with the fault in almost exactly coincident beds, to which the arrow points, we should have had little doubt of their former continuity. But in this stone they have never been in any other than their existing position, any more than the two upper beds on the left, of which one is an entirely undisturbed branch of the other, as much as any branch of stalactitic chalcedony is of the rest of the mass Nor have any of these beds ever been broken at all. The whole is a tranquil determination of variously crystallizing substances, like that of the component minerals in granite. The white portions are hornstone; the black band in each is ferruginous, and the enclosing paste rudely crystalline quartz.

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[1] For former papers see Geol. Mag., 1867, Vol. IV. pp 337 and 481; also 1868, Vol. V. pp. 12, 156, and 208.

There is, however, one grave structural difference between this stone and common granite. The crystals in granite run in all directions. These zones of hornstone have a more or less parallel direction; and the black band, with another narrow one succeeding it, is always at the same side of them.

I have placed the woodcut (Fig. 1) with the black beds uppermost, so that the resemblance may be seen between them, and the always uppermost grey beds in the highest division of Plate XV. Vol. IV. But in neither case can I say that their position has been influenced by gravity. For in Plate XV. it will be observed that the elliptical bar of central calcite crystallizes in every direction, and in this piece of hornstone, very near the portion above figured, is a cavity, in which while the bands whose separation forms it, retain their relation unchanged, the quartz, having now room to crystallize, does so indifferently up and down, and from both sides, as in Fig. 2. I do not know the position of the stone *in situ*.

But though common granites show only arbitrary positions of crystals, in graphic granites we have a definitely parallel arrangement of them, somewhat resembling this of the hornstone, only more regular; and in massive felspathic rock we get the same deceptive resemblance of faults exquisitely defined. Fig. 3 represents (of the real size: as are also Figs. 1 and 2) a portion of felspathic rock in which two crystals of labradorite are separated by apparent breccia, but really, crystalline mass, of mixed labradorite and hyperstein. The oblique lines stand for this gangue (merely for a symbol — there are no lines nor cleavage in the gangue itself). The white spaces are pale blue labradorite, the horizontal lines indicate in each crystal a sharp, exquisitely defined, zone of vivid

FIG. 2.

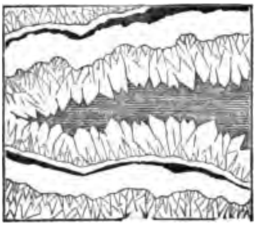
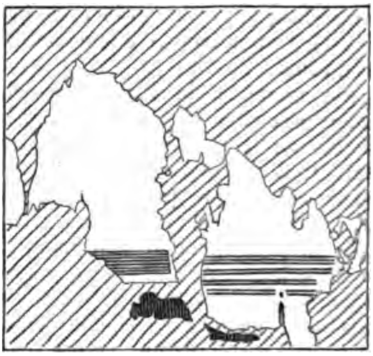


FIG. 3.



orange, and the vertical lines a zone of intense blue. There has evidently been no fracture in this case, any more than between the felspar crystals of common granite. And the—in this instance absolutely accurate—coincidence of direction in the zones of the detached pieces, with their fault-like variation in breadth and relative position, are both of them entirely crystalline phenomena.

Now we must always remember that in chalcedony and quartz we have two entirely distinct groups of crystalline forces; one radiant, endeavouring to throw the mass into spherical concretions; the other rectilinear, endeavouring to reduce it to hexagonal crystals: and that both of these are capable of producing phenomena of relative distortion.

Also, the group of the spheric forces associates itself delightedly with the spheric forces of hydrous oxide of iron, thus producing endlessly fantastic groups of mixed iron and chalcedony, while the rectilinear forces ally themselves in like manner to those of micaceous iron, bournonite, heavy spar, and calcite, producing tabular groups of crystals which present close analogies to the flat leaves of chalcedonies which, have metallic or earthy laminæ for their support; while the iron-oxide, when it has no longer the power of modifying the shapes of the crystals, sets itself to imitate two other minerals frequently found in them. It mimics the globes of brown mica so exactly with its own bossy groups of clustered laminæ, that only a strong lens, or the knife, will distinguish them, and, in the interior of crystals, throws itself into golden-coloured radiant or circular sheaves which, when within amethyst, are the most beautiful things I know among minerals; but which it is a matter of great difficulty to distinguish in common quartz from minor forms of rutile. Finally, to crown the complexity of this iron and flint group, the sulphide of iron, varied beyond all minerals in the phantasies and grotesques which it can build out of its plastic and innumerable cubes, shoots its stellate crystals through the mass of the hydrous oxide, and disputes with it the central position in stalactites of chalcedony.

But, through all this confusion, one generalization presents itself which is of great value. Whenever iron, whether oxide or sulphide, is associated with stalactitic chalcedony, it is always in the centre of the mass; but when iron, whether oxide or sulphide, is associated with quartz crystals, it is always (if determinately placed at all), either on the outside, or at a slight depth below the surface, under an external coat of clearer crystal. It may be indeterminately placed, in dispersed stars or cubes; but, if ordered at all it is ordered so. Briefly, a crystal of quartz never has a *centre* of iron, and a crystal of chalcedony never a *coat* of it.[1]

And an important result seems to follow from this. If stalactites of chalcedony were formed by superfluent coats, some of these coats would have iron in solution at the outside as well as the interior, and would secrete it in successive films; whereas, on the contrary, the entire bulk of the iron, being always central, must surely have been secreted out of the entire mass; and, therefore, I believe that the true chalcedonic stalactite is indeed a long botryoidal crystal, like some of the forms of sulphide of iron, found in chalk, and not at all a drooping succession of fluent coats, except in cases of rapid deposit, which, as far as I remember, show no central iron.

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[1] Of course I do not vouch for any so wide generalization as this absolutely. If ever one ventures to do such a thing, the next stone one takes up on a dealer's counter is sure to be an exception to the announced law; but I am confident that any mineralogist can fortify the statement from his own experience quite enough to justify our reasoning upon it.

Again, when iron is systematically associated with quartz, it is never in the centre of the crystal, but either on the surface or under an externally imposed glaze. Hence it follows that the crystalline forces at work in forming quartz act nearly in the reverse of those that form chalcedony, as regards the direction of ferruginous elements, and that they have quite a peculiar power in finishing crystals, which determines, at a given time, either a purer, or an amethystine, silica to the surface, often throwing down crystals of iron between the two.

I have already noticed the clear coat forming the exterior of many nested agates in basaltic cells, and the deposit of iron succeeding it, to which I gave the name of medial oxide. My impression is that the exterior of such agates, as relating to the crystalline power, may be considered identical with the centre of a stalactite, and I think it will be found that the iron in such stalactitic centres, however delicate the fibre of it, is not solid, but tubular, leaving the absolute centre of clear silica correspondent to the surface of clear silica in a quartz crystal.

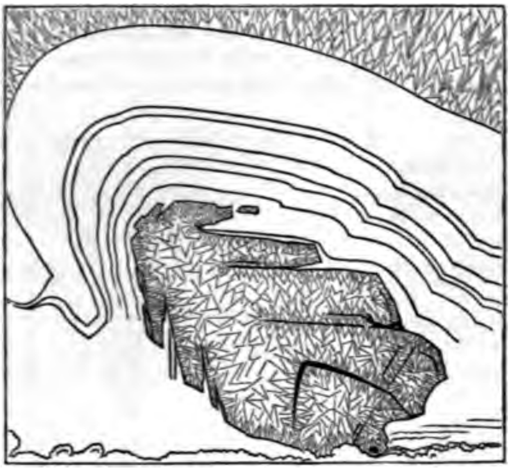
It is very strange that among these complicated forces certain conditions of chalcedony and quartz should be so constant, and the intermediate states, giving evidence of formation, so rare; but though the interior of almost every quartz crystal shows the forces of agatescence and straight crystallization in confused contest, I have only seven or eight specimens, out of a collection of some thousands, which clearly show the balance of the two powers in accomplished structure.

The uppermost figure in Plate XIX. represents a portion of one of these, which is a stellar agate, formed of grey chalcedony, with white bands collected in a knot within radiant quartz. The precision of its lines is beyond all imitation, but Mr. Allen has succeeded in drawing and engraving it for us quite well enough to show the repeated efforts of the chalcedony to throw itself into straight crystalline planes, successful, tremulously, here and there for a quarter of an inch, and then thrust again into curvature by the lateral spheric force.

The second example, engraved in the lower figure in Plate XIX., shows the two forces reconciled in their reign: the crystalline or mural form is completely taken by the agatescent bands in one part of the stone and the spheric in another, while the bands themselves are arranged in double folds, turned at the extremities, like the back of a book.

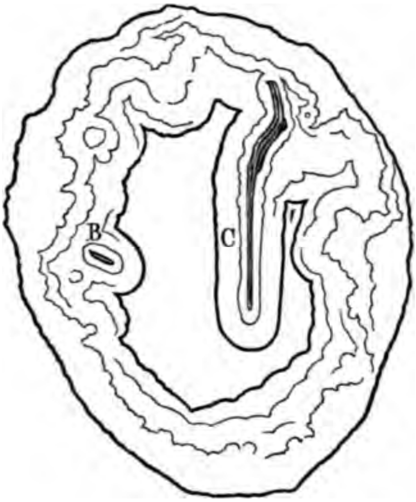
Finally, the wood-cut, Figure 4, gives the rude outline of a stone in which the central nucleus of confused quartz has made vigorous, repeated, and, as far as I know quartz, I may even say super-quartzine efforts to gather itself into a single crystal, dragging the circumfluent agatescent lines one after another violently aside, to expire in the planes of its successive pyramids.

Fig. 4.



In all these instances the crystalline action is unmistakable, being at relative angles, of which only agatescent warping deranges the magnitude, but here (Fig. 5) is an example in which we have an

Fig. 5.



apparently pendant stalactite (which is, however, the section of a vertical wall) without evidence of any relative planes, except the very short and secondary one on the left. Yet, between conditions of this kind and true stalactitic agates, there is a gap which at present I cannot bridge. The mural agate consists of concretions in flat planes, formed irrespectively of gravity; the stalactitic agate, of concretions on central rods, formed with reference to gravity. I have, indeed, one example in which these central rods are incipient in formation;—are as fine as hairs, and are connected, as in Fig. 6, by drooping branches concurrent with the successive outlines of the falling mass; and another, Fig. 7, in which the tubes of a folded agate have become crystalline, and are clearly minded to determine themselves into straight lines. But these are both small, and of structures too unusual to found reasoning upon. I shall engrave them, however, hereafter, but before examining these and the other structures illustrating the connection between mural and stalactitic agates, it will be better to trace the closer connection on the other side between mural and conchoidal agates. The states intermediate between these two will be the subject of my next paper.

Fig. 6.

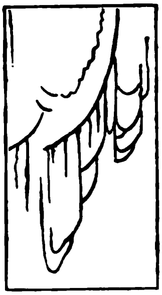
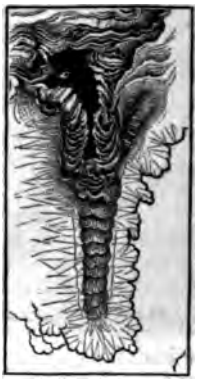


Fig. 7.



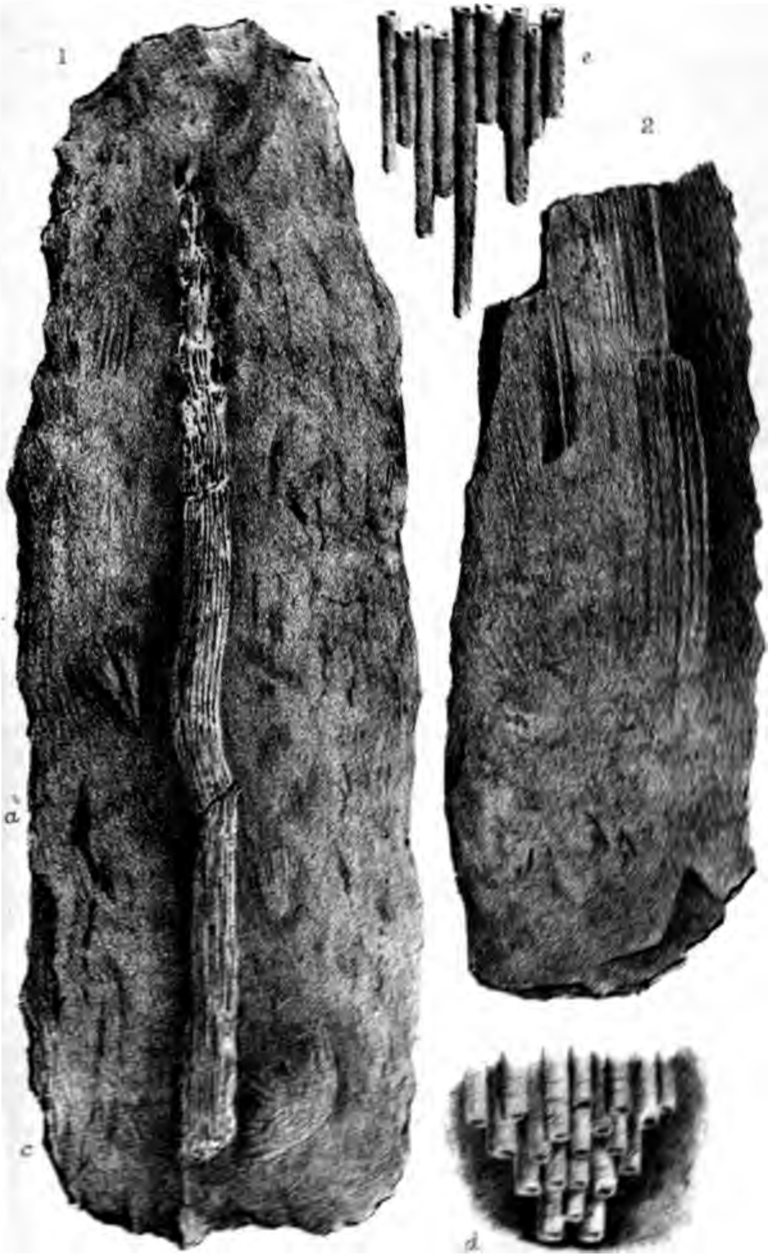
II.—Notes on a Species of Eophyton (?) from the Lower Arenig Rocks of St. David's.

By Henry Hicks, Esq.

(PLATE XX.)

As none of the figures hitherto given of the genus *Eophyton* show either its internal structure, or articulations of its stems, and as I am in possession of a specimen from the Lower Arenig Rocks, of Ramsey Island, near St. David's, which resembles in some respects the *Eophyton Linnæanum* Torell, but which shows both articulations of the stem, and an internal vascular structure, a description of the species may probably be useful, and may tend to elucidate the true nature of *Eophyton*, concerning which so much doubt seems to exist at present.

Geol. Mag. 1869 Vol. VI. Pl. X.



[illegible]

[illegible]

There can be no reasonable doubt of the vegetable nature of this fossil, and I think its affinity to the vascular Cryptogams is most clearly shewn.

These Lower Arenig Rocks, from whence the specimen was obtained, rest apparently quite conformable on Upper Lingula-flags,[1] and underlie the true Arenig or Skiddaw rocks. Nearly all the species obtained from these beds are new, and they indicate a fauna intermediate between Tremadoc Rocks, and the true Arenig Rocks. Indeed, in the report to the British Association, by Mr. Salter and myself, in 1866, they were classed as Tremadoc Rocks; but I have since thought it advisable to separate them and to place them in an intermediate position. The Brachiopoda from these rocks have been described by Mr. Davidson (Geol. Mag., Vol. V. p. 303), but all the other species are yet undescribed.

Eophyton (?) *explanatum*, n.sp., Fig. 1. Pl. XX.—A raised, moderately convex stem, about 4 lines in breadth; widening, however, and becoming somewhat compressed at the joints. The surface is ribbed, and furrowed along its whole length. At the lower joint (*a*) the ribs bend outwards, evidently to form a branch. The joint is obliquely placed, widened out, and its course distinctly marked by a deep sulcus. The cortical substance is very thin, and can be removed to shew the internal structure. The internal structure is made up of compressed columns, running the whole length from joint to joint, evidently of a tubular nature, and bound together by very thin tissue. These are well shewn at *b*. At *c*, being the base of the stem, the broken ends are visible. Figs. *d* and *e* are these parts magnified.

Fig. 2 most likely belongs also to this plant, but the characters are not well marked.

Unless *Eophyton Linnæanum* is proved to have a jointed stem, and an internal structure similar to our specimen; it will probably be necessary to make a generic distinction, but at present it is better to retain this under Dr. Torell's generic name.

III.—On the Pretended "Raised Sea-Beaches" of the Inland Slopes of England and Wales.

By G. Poulett Scrope, F.R.S., F.G.S., etc.

In the number of this Magazine for July, 1866, p. 293, I ventured to characterize as "preposterous," the opinion advanced by Mr. D. Mackintosh in two preceding papers (Geol. Mag., Vol. III. p. 69, and p. 163) that the very numerous terraces that occur on the sides of the Chalk and Oolitic hills of the southern and western counties were, "without doubt, *raised Sea-beaches*," affording, therefore, evidence of the *very recent* elevation of these hills from beneath the sea-level, since the complete excavation of the existing valleys.

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[1] So marked in the Geological Survey Maps. I am inclined, however, to think that they are representatives of the Tremadoc rocks, for *Ling. Davisii*, which is the only fossil present, is equally characteristic of Tremadoc rocks, and reaches here also into these Lower Arenig rocks.

Mr. Mackintosh replied in a brief paper, in which he refused to accept my correction of his theory (Vol. III. p. 381), declaring that, "so far as his observations have extended, the *plough*" (to the action of which I had attributed the formation of these terraces) "would appear to obliterate rather than form regular systems of terraces such as he had described."

In his recently issued volume, "The Scenery of England and Wales; its Character and Origin," which was reviewed in the October number of this Magazine, Mr. Mackintosh repeats and enforces his views as to the *marine* origin of these terraces, with a contemptuous allusion to my "Agricultural theory" (p. 92).

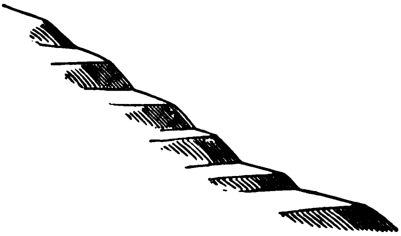
Now, since the causes which have modelled the existing surface-forms of this island have a real geological interest of no little moment—especially as the same causes, if of a geological character, were no doubt at work very generally throughout the world during the same period,—and as those to which Mr. Mackintosh assigns the terraces in dispute indicate a very recent emergence from the sea, and elevation of the entire island by at least a thousand feet; and also that this process took place through a series of slight steps or jumps locally of a few feet at a time, corresponding to the intervals of height between the numerously repeated terraces,—the question becomes one not of mere controversy between individual geologists, but of some importance in its bearing on general geological history. This consideration will, I hope, be my sufficient excuse for once more calling attention to the matter in dispute between Mr. M. and myself. I must refer the readers of the Magazine to my paper already mentioned (July 1866, p. 293) for the arguments employed by me in support of the agricultural origin of these terraces, popularly called Lynchets, or Balks, being unwilling to repeat them here. But as Mr. Mackintosh reproduces his theory of their marine origin in his present volume, with some additional illustrations and examples, I will quote some passages from that work in order to show the extent to which, if adopted, it would carry us, appending as we go on a few brief comments.

In p. 85, he instances "the successive levels of the Brent knoll and its connected platform" as "terraces of marine erosion, *which could never have answered any human purpose*," but which may be explained by "the action of a not very powerful sea, at different tidal levels, during a gradual rise of the land." How or why these levels could not have answered the purpose of facilitating the culture of the steep slope—especially to the population which at one period encamped for safety on the summit of the knoll, Mr. M. does not explain. He proceeds to say, "In the adjoining district traversed by the Glastonbury and Temple Combe Junction a geologist *becomes bewildered* among the thickly crowded variety of these denudational phenomena. Among them he can here and there discover single terraces and sets of terraces, *nearly all corresponding to the outcrop of the strata, and therefore not artificial*."

Why so? If the outcrop of a stratum or series of strata of rock harder than the rest, on the slope of a hill, be tolerably horizontal it would follow as a matter of course that the softer surfaces of the slope, above and below it, will have been preferably subjected to aration, and in time the ordinary result would appear in the accumulation of a considerable depth of silt and gravel—the washing of the plough-disturbed surface above—on the brow of the harder stratum, while its base would be eaten away through the action of the plough, and the loss by descent to a lower level of the matter so disturbed; thus by degrees a small cliff or bank (balk) would be formed, chiefly consisting of hard rock, between the upper and under arable terraces. And this surely must be called an "artificial terrace," though the occurrence of a hard stratum of "natural" rock directed the operations of the plough. Indeed, it is obvious that in all cases of the alternation of harder and softer groups of horizontal strata in a hill-side, the agriculturist would follow the direction of the softer portions in ploughing the slope, leaving the harder as banks to support his arable terraces, just as the vine-growers of the sunny slopes of France, Germany, and Italy, avail themselves of the outcrop of harder strata to assist the formation of the walls which support the "artificial" terraces, built up by them to check the descent of soil from above.

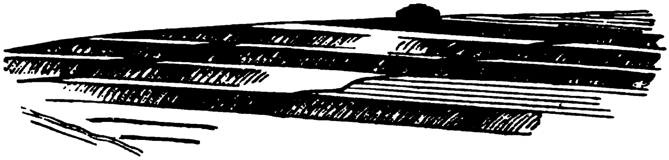
Mr. Mackintosh tells us in his preface that he has never been out of this island. It is therefore probable he is not aware of the extent to which the cultivation of hill-slopes by the system of artificial terraces is practised throughout the continent, nor of the general character of such terraced slopes. Otherwise, I think, he would hardly have presented his readers with the example of "Terraces of Marine Erosion," of which the accompanying woodcut is a copy (p. 88).

Fig. 1.—Profile of Terraces on the Side of a Chalk Hill near Twyford.



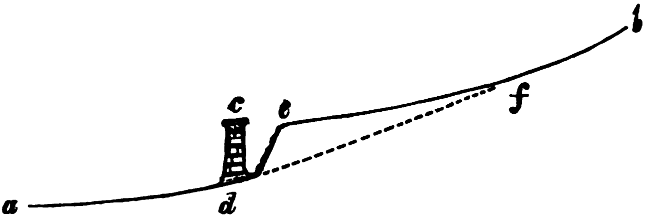
On this he remarks—"Unless we can conceive of our ancestors having been endowed with so great a *taste for the picturesque* as to dig out chalk for burning in a series of ornamental steps or shelves, I can see no agency likely to have formed these terraces excepting *oceanic currents*, at different levels, with or without floating ice" (!). As a "pendant" to this example of a steep-terraced hill, I copy one other of Mr. Mackintosh's cuts representing "the most regular series of terraces I have yet seen in the Chalk district, which occurs on the side of a hill to the south-west of Stockbridge, the slope being so very gentle that there could have been no inducement to break it up into terraces as a means of facilitating cultivation."

Fig. 2.—Terraces near Stockbridge.



It was to meet such cases as these of gentle slopes so terraced that, in my paper above-mentioned (Vol. III., p. 293), I suggested the probability that each of such terraces might have been in early times strips of land held by separate occupiers (as was up to a very late period the custom in many "common fields," and is at present through a large part of France), the "bank" having been originally perhaps only a grassy border, or a slight fence, either of which would be enough to arrest the descent of silt during rains from the surface of the ploughed strip above, and by its long-continued accumulation upon this edge raise there by degrees a steep bank, while the slope above would, by the same process, rise into a nearly level terrace. As a practical proof of the correctness of this theory, I stated that these banks might be observed by any long resident in the country to *grow* in height, and gave a cut representing one that I had myself seen *wholly created* within a few years by this process. I will now add another to exemplify the fact that it is by no means necessary that a fence should exist along the lower edge in order to stop, by its resistance, the descent of silt, gravel, etc., from the slope above. I could adduce numberless instances in which, when there did exist such a fence, the silt has been deposited in a bank stopping short, and leaving an interval like a ditch, of a yard or two wide, between itself and the fence below. It happens in this wise (see Fig. 3),

Fig. 3.—Terrace and Bank caused by Descent of Silt, etc.



A, B represents the profile of a hill slope, towards the base of which a fence,—say a stone wall, C, D separates the arable field B, E from the one below A, D; the dotted line D, F, represents the original surface. But by the continued ploughing of that surface in horizontal furrows, aided by the wash of the disintegrated soil during rains, much of it has been carried down to form the bank and terrace, D, E, F, at the bottom of the field. The descending silt, however, does not actually h the wall, for the reason that the plough never can be driven ıin a few feet of it; a small strip of unploughed and conıently grassy surface will always intervene between the last ow and the fence, and however slight this obstruction, it is icient to check the descent of silt, and cause it to accumulate in lowest furrow. By repetition of this process through a series years, the bank is formed, maintaining a certain distance from wall, as seen in the woodcut. And thus, it will be perceived, t the bank and terrace above, would be produced equally, whether nce existed below it, or only that the lowest limit of aration was ginally marked by a grassy ridge, a few inches in height.

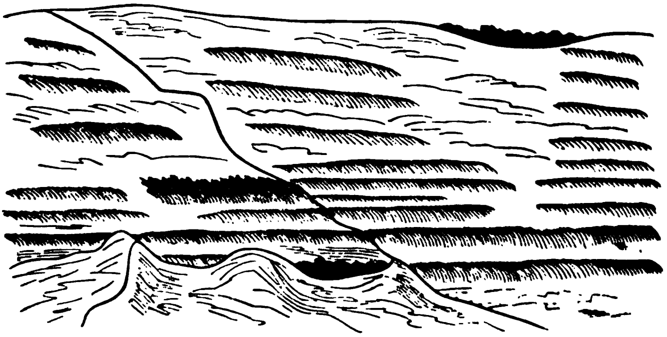
ll this minute explanation of the humble origin of these banks, however, mere moonshine to Mr. Mackintosh, who prefers to ıg the ocean up to and above the tops of our Chalk and Oolite s, to account for the petty features with which their sides are red. It is true that in his recent volume (p. 88) he seems, ugh in an equivocal manner, to admit that *some* of the banks, aces, etc., *may* have been formed artificially; while in his earlier er he denied this origin to any. He now only ventures to say, t is, I think, by (marine) currents acting on an easily moulded terial, that *many* of the terraces of the chalk downs can be most isfactorily explained." This, of course, makes the intervention of ocean, and consequently the recent elevation of the surface of island from beneath it, just as indispensable as if *all* the terraces re ascribed to its erosive action. So that nothing is gained by evasive admission. Only a perplexing doubt is introduced as which of the "thousands of terraces" to be seen at different els on the hill-sides of Wiltshire, Dorset, Hants., and other of our ınties, are to be ascribed to the work of Giles Ploughman, and ich to mighty Neptune. They were all "raised sea-beaches" in . Mackintosh's paper of July, 1866, now some are, and some are ;! I venture again to maintain that *all* are of artificial origin; l that consequently no proof is to be derived from them, either of very recent sojourn of the sea upon the summits of our hills, or the "very limited amount of atmospheric denudation in the Chalk l Oolite districts," which was another most important inference ıwn from these terraces by Mr. M. (Vol. III., p. 69). They, in th, lead to the very opposite conclusion, showing indisputably w largely atmospheric influences have altered the form of the sures exposed to them, within periods of a very few years' duration.

It is hardly worth while to notice some futile objections urged by . Mackintosh to the agricultural orgin of the terraces, such as that strips of arable could not have been held "in severalty," because h divisions are not mentioned in title-deeds, etc.; whereas it is torious that nearly all old terriers of estates contain mention of gle acres, half-acres, or other small quantities of land, so held in common arable fields of the manor. But, of course, in sugsting the possibility of the terraces having in some cases origited in their having been held in early times by different cultitors, I by no means intended to suppose this to have been the fact in all cases. Probably also many such terraces were intentionally formed by the farmers, with the pick-axe, with the object of preventing the descent of soil to the bottom of the hill, and of widening the arable surface; as is constantly done by the continental cultivators of similar slopes. Again, Mr. Mackintosh says, "Many farmers have assured me that there is now, and has long been, a general desire to plough down the 'lynchets,' and that formerly their number was much greater than at present" (p. 89). No doubt, in the course of time, as two separate strips, "or lands," become united in one estate, or held by the same tenant, it would be for his interest to "plough down" the bank between them, which, being composed chiefly of the finest mould, washed down in preceding years from the slope above, would enrich the impoverished land at its base. And, indeed, this occasional "ploughing down" of the banks accounts satisfactorily for their partial disappearance on some points, as well as their "gradation into the more general slope of the ground," which naturally seems to have "bewildered" Mr. Mackintosh, on the assumption of their marine origin. But, supposing the banks to be "marine terraces," and, therefore, often composed of shingle and shells, this "general desire to plough them down," would be unaccountable. In truth not a single example of a terrace so composed has been produced by Mr. Mackintosh, and I venture to assert none such will ever be found in the situations indicated in his theory.

We all know what a sea-beach is. The Chesil bank is an admirable example. There is another stretching eastwards, along many miles, from the base of Beachy-head to Hastings. They are composed, like all sea-beaches, I believe (differing in some respects from flat sandy shores), of rolled pebbles or boulders, with or without an admixture of sand, broken shells, and other sea-wrack. Has Mr. Mackintosh examined any of his "raised sea-beaches" and found them, or even any one of them, to be so composed? Not one! Has he produced a single sea-shell found in any of them? Not one! Throughout his whole description of these numberless banks and terraces, I cannot find that he has even attempted to examine the composition of any—with the single exception of one of a "Series of Terraces near Llangollen," "*the finest series of undoubted Old Coast-lines or raised Sea-beaches* I have yet met with, on the face of a hill to the south of Llantysilio railway station—the highest terrace reaching an elevation of at least 1500 feet." *One* of these, *close to the railway station,* Mr. Mackintosh *did* examine (I presume while the train was stopping, as he says "*I had not time to make a particular examination*")—but "it seems covered with *fine clay,* mixed with small stones, some of which are much rounded, and, *where the soil has been thrown up by moles,* it appears mixed with the refuse of decayed shells"—land shells, no doubt. And *this* is the sole *fact* or observation relative to the composition of these "innumerable *raised sea-beaches,*" which Mr. Mackintosh affords his readers, if we except the statement that "Mr. Codrington, F.G.S., *and others,* have ascertained that a number of the terraces have a deposit *of ap-*

parently made earth on their brows" (p. 66). Of course; and this "made earth," or, in other words, silt and soil, with land shells, fine gravel and small stones, loosened by the plough from the surface-slope above, and washed down by the rains until some hedge, or wall, or even less trifling boundary, more or less horizontal, checked the downward wash of surface matter, will be found, if I mistake not, to form the substance of all these terraces and banks—except where some harder stratum crops out from the hill-side, and gives a support to the arable terrace above.

FIG. 4.—TERRACES NEAR LLANGOLLEN, AS SEEN FROM THE HILL NORTH OF LLANTYSILIO RAILWAY STATION.



No one, of course, disputes the existence of true sea-cliffs and escarpments, or of raised sea-beaches on some of the coast-lines of our island, or that some of the latter may penetrate its estuaries, and be found at considerable heights above the present tidal level. Where sufficient evidence of these latter facts is produced, they are, and will be, readily accepted by all geologists. It is to the innumerable minor banks and terraces (popularly called balks and lynchets) which Mr. Mackintosh truly describes as scoring the sides and reaching to the summits of many inland hills in the Cretaceous and Oolitic, and other formations of our island, that my remarks refer. These, I believe, to be of artificial origin,—to be owing to the disturbing action of the plough and the mattock on the surface-slopes, aided by downward rain-carriage of the loosened soil—a process which is *visibly* going on wherever a hill-side is under cultivation. And I look on Mr. Mackintosh's notion of their being "raised sea-beaches" as a preposterous theory without a shadow of foundation.

On the whole, it is evident that before Mr. Mackintosh can be accepted as a reliable authority by his readers on the "Causes of Denudation, and the origin of Natural Scenery throughout England and the World," he must unlearn many of his present notions upon the "very limited power of atmospheric," and the almost exclusive agency of "marine denudation," in shaping the surface of our continents, which compose the substance of his recent volume. If as a lecturer he repeats this theory of denudation to an agricultural audience in the southern counties, he will be liable to some such muttered interruption from an incredulous old farmer, as that of Edie Ochiltree to the Antiquary's far-fetched assertions—"Sea-beach here, sea-beach there; *I mind the bigging of 'em.*"

IV.—On the Middle Pleistocene Deposits.

By Professor Harkness, F.R.S., F.G.S.

THE superficial deposits of the Co. of Wexford, containing a rich marine fauna, have been referred to in Professor E. Forbes's Memoir on "The Geological Relations of the existing Fauna and Flora of the British Isles."[1]

In an appendix to this memoir the several shells which have been obtained from the superficial deposits of this portion of Ireland are mentioned. A list of the fossil contents of these deposits had been previously given by Sir Henry James, who first pointed out the occurrence of these shell-bearing strata in the Journal of the Dublin Geological Society, Vol. III. The fossils mentioned in this list have been also determined by Professor E. Forbes.

The strata affording these fossil shells are described by Sir Henry James as very extensively developed in the Co. of Wexford, and occupying an area forty miles in length, by from eight to nine miles in breadth. They consist of sands and gravel and drift, and repose upon rounded pebbles." On the sides of the Firth Mountain they attain an elevation of 400 feet above the level of the sea. Their thickness near Blackwater is said to be 174 feet, and their base is nowhere seen.

On four of the sheets of the Geological Survey Maps of this part of Ireland (sheets 47 S.E., 47 N.E., 41 S.E., and 41 N.E.), these strata are referred to as follows:—"The low lands of this coast and the interior up to a height of between two and three hundred feet are covered by Pleistocene deposits, consisting of marls interstratified with sand and gravel, containing Arctic and other shells, chalk-flints, pebbles of Antrim chalk, jasper, coal, etc., and magnetic iron sand." Many of the species of shells which occur in these beds are in the Museum of the Geological Survey of Ireland, and the several localities from whence the specimens have been obtained are recorded on the underside of the slabs upon which they are mounted. By the kind assistance of Mr. Baily, Palæontologist to the Irish Survey, I have been able to give the following as localities from whence these specimens have been derived:—Ballyteige, Killiley, Rathaspick, Castle Ellis, Killisk, Ballyhuskard, Artramon, Ballyvaldon, Ballyknockan, Killmackridge, St. Margaret's, Killinkorley Clonmure.

The portion of the Co. of Wexford where these superficial deposits occur is marked by a circumstance which at once recalls, to the minds of those who have seen them, the Boulder-clays of Lancashire and Cheshire, and their associated strata. Great numbers of pits are seen scattered over the parts of Wexford where the superficial deposits are formed; but by far the greater portion of these have been abandoned for many years, and are now full of water. From these pits have been derived materials used in the improvement of the land, and in every respect they are analogous to the marl pits in the English counties above alluded to. There are now very few dry pits in the northern portion of the area occupied by the superficial deposits in the Co. of Wexford; and those in the southern portion of the county afford very little evidence concerning the relative position of the strata which they exhibit.

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[1] Memoirs of the Geological Survey, Vol. I.

Sir Henry James has stated that the base of the superficial deposits in this part of Ireland is not seen; and to this might be added, that for the most part we have little information as to the strata which are newer than the shell-bearing sands and gravels of the Co. of Wexford. There are, however, a few localities where strata of a different nature, and with well-pronounced features, are seen resting upon the shell-bearing deposits.

One of these localities is in Castle Ellis, about a quarter-of-a-mile north of the Post Office, in a field on the east side of the high road. Here there are two dry pits, one of which has recently been worked for material for the land. The sides of this pit exhibit a mass of reddish-brown Boulder-clay, about forty feet in thickness. This clay rests upon sandy and gravelly strata in some instances, almost consolidated by the infiltration of carbonate of lime. These sands and gravels forming the lower beds of the pit, are only exposed to the depth of about twelve feet.

The Boulder-clay above them abounds in angular, subangular, and rounded blocks of rocks, derived principally from the Cambrian and Silurian formations; and, in many instances, these blocks are beautifully striated.

Some of the sandy layers are very strongly impregnated with small particles of shells; and it is from these layers that the materials which are used for the improvement of land are obtained.

In Castle Ellis, on the same side of the road, a short distance south of the Post-office, there is another large dry pit, the upper portion of which also consists of Boulder-clay. Here, however, the Boulder-clay is not more than twelve feet in thickness, and the rest of the pit, which is of considerable depth, is made up of sands and gravels. A little further to the south, on the opposite side of the road, another dry pit occurs. The latter consists of sands and gravels exclusively, the Boulder-clay having thinned off before reaching this spot. The sands and gravels in the last mentioned pit are now largely worked, and, in common with the same deposits in other parts of the Co. of Wexford, they are known as "Manure gravels." It is to the abundance of fragments of shells, which occur in these deposits, that they owe their value for agricultural purposes.

Some other spots on the road from Castle Ellis to Wexford afford also "Manure gravels." One of these is at Pulregan, near Castlebridge. Here, and in several other localities, the "Manure gravel" deposits exhibit a rounded outline, having much of the contour of Eskers. At Pulregan, besides numerous fragments of bivalve shells, univalves are also found in the gravels, some of which are in a perfect state.

In the neighbourhood of the town of Wexford, and to the south thereof, the same deposits make their appearance; but here, as elsewhere, the strata on which they repose are not seen, and here they have no Boulder-clay above them.

Of the species of shells determined by the late Prof. E. Forbes from the "Manure gravels" of the Co. of Wexford, forty-three are common British forms, amongst which is *Fusus antiquus*, the variety *contrarius* being abundant among the specimens in the collection of the Irish Geological Survey. The specimens of this form, collected by myself from Castle Ellis, were of the ordinary variety and of small size. Nine of the species from the "Manure gravels" are forms which now occur in the northern British Seas; seven appertain to Boreal America, or to the coast of Greenland; and four are now found in seas south of the British Isles. Taking the whole of the shells, they appear to indicate a temperature somewhat colder than that which prevails in the present sea of the Wexford coast, but by no means such a rigorous climate as is represented by the shells which have been obtained from the deposits of Scotland and elsewhere reposing upon the Boulder-clays.

The occurrence of Boulder-clays above the shell-bearing sands and gravels of the Co. of Wexford, would, at first sight, induce the conclusion that these strata appertain to a horizon nearly allied to that of the Norwich Crag; and this inference is, to some extent, prevalent concerning them.

It is, however, necessary to look for their equivalents elsewhere, and to see the conditions under which those equivalents present themselves, before arriving at any conclusion as to the age and position of the "Manure gravels." There are two features in connection with these "Manure gravels" of the Co. of Wexford which are highly characteristic of them: one is, the presence of shells, and fragments of shells, which distinguishes them from Eskers, to which they are nearly allied in arrangement and in the general nature of their contents; the other feature which marks them is the constant occurrence in them of flint pebbles, which are almost altogether absent from the Eskers.

There are several localities in Ireland where beds, having the same nature and affording precisely the same contents as the "Manure gravels" of the Co. Wexford, are to be found.

One of these localities is the north side of the headland of Howth, the northern boundary of Dublin Bay. The strata, which are here well seen near the village of Howth, have been described many years ago by Dr. Scouler.[1] They consist of sands and gravels, the latter being limestone fragments, with which are associated flint pebbles. The section is about 200 feet in thickness; and Dr. Scouler states that the beds afford *Turritella terebra*, *Turbo littoreus*, *Nerita littoralis*, *Buccinum undatum*, *Cardium edule*; *Cyprina Islandica*, *Pecten varius*, and *Dentalium entale*, generally in a fragmentary condition. These shell-bearing beds, with flint pebbles, rest upon a mass of Boulder-clay containing abundance of striated blocks, well seen at Balscaddan Bay; and this Boulder-clay reposes immediately upon the Carboniferous limestone.

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[1] Dublin Geological Journal, Vol. I., p. 270.

The position of the shell-bearing beds, with flint pebbles, at Howth, *resting on Boulder-clay*, would at first sight appear to indicate a different and a higher horizon for these strata than for beds having the same nature in the Co. of Wexford, since the latter have Boulder-clay above them.

It must, however, be remembered that, in the Wexford area, the strata upon which the "Manure gravels" rest are not seen.

On following the gravels and sands of Howth, eastwards, they are found to be covered by Boulder-clay, which does not exceed more than three feet in thickness; and this Boulder-clay most probably represents the lower portion of the similar deposits which, in Castle Ellis, in the Co. of Wexford, covers the "Manure gravels."

Subsequently to the observations of Dr. Scouler on the shelly gravels and sands of Howth, Dr. Oldham has described beds of the same nature which occur in other parts of Ireland.[1] He also notices the appearance of flint pebbles in these strata; and he adds to Dr. Scouler's list of shells the following species:—*Ostrea edulis*, from Killiney and Bray; *Tellina solidula*, not uncommon; *Pecten opercularis*, from Killiney; *Pullastra decussata*, from Killiney and Bray; *Nucula oblonga*, *Astarte Gairensis*, from Killiney, Bray, and Sugarloaf; *Nucula nucleus?* and *Saxicava rugosa*, rare. Further observations in these beds also induced him to add to his previous list the following forms as occurring near Dublin:—*Rostellaria pespelicani*, *Fusus antiquus*, *Buccinum undatum*, *Nassa incrassata*, *Natica Alderi*, *Littorina neritoides*, *Trochus umbilicatus*, *T. ziziphinus*, *Triquetra* species of *Spirobis* sp., *Balanus* (impressions of).[2]

Since the observations of Dr. Oldham were made on these deposits, as they are seen in the districts around Dublin, they have attracted the notice of the Rev. Maxwell Close, who has paid special attention to the Glacial phenomena of Ireland. The Rev. Mr. Close has recognized the occurrence of the shell-bearing sands and gravels in the high ground to the south of Carrickmine's station, on the Dublin and Bray railway.

Here flint pebbles also make their appearance, and shelly fragments, the most abundant being portions of *Cyprina Islandica*.

The Rev. Mr. Close has also detected these shelly sands and gravels on the south side of the Three Rock Mountain, at an elevation of about 1,200 feet above the sea level.

The several species of mollusca, which have been obtained from the sands and gravels in the neighbourhood of Dublin, are such as are most common in the "Manure gravels" of the Co. of Wexford; and, like them, they do not indicate Arctic conditions in the seas in which they lived.

Sands and gravels of a nature similar to those of the neighbourhood of Dublin and the Co. of Wexford, have been found in other parts of Ireland; and where they occur t flint-pebbles and contain shelly fragments. are well seen is at the south-eastern extre near Youghal. Here they form on the coas Castle, having a height of ninety-one feet, gravels and sandy clays, which make up th the strata on which they repose not being vi

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[1] Op. Cit., suprà, Vol. III., p. 61.

[2] Op. Cit. suprà, Vol. III., p. 181.

These deposits and their shelly contents Mr. A. B. Wynne.[1]

I have not noticed these sands and gra Youghal; but I learn from Mr. G. H. Geological Survey, that they are to be se Crookhaven, the extreme southwest portion

Strata of the same character as those of flint-pebbles and afford marine remains, hav several parts of Britain. Across the Irish diately opposite the sands and gravels of th the sides of Dublin Bay, are the shell-bear the eastern side of Moel Tryfaen. These have no Boulder-clay below them like th repose directly on the Cambrian slates. In these Welsh strata are almost identical with of the Co. of Wexford, and they, too, co flint pebbles.

As regards the shelly contents of the M greatly resemble such as are afforded by the but on the whole they have somewhat more

There are also in the valley of the Sever and Shrewsbury, deposits which seem to bearing beds of Ireland. These have been They consist of sands, gravels, and clays, wl rounded contour, as at Strethill; and in this the outline of many of the deposits of "Ma of Wexford.

These strata of the valley of the Severn a and afford marine remains. I am indebted lection of these remains; and they, toge tioned in Mr. Gwyn Jeffrey's list appende have a great analogy to the shelly contents gravels.

Many localities in Cheshire and also in I a series of shells very nearly identical with from the several localities above named. these countries have been reached, in many c a deposit of Boulder-clay, with well striate that which overlies the "Manure gravels these shelly deposits, which effervesce freely same objects as their equivalents in the Coun agricultural purposes. Beds of sand are often found associated with the shelly marls; and in the neighbourhood of Preston in Lancashire where the shell-bearing strata are seen, they are described by Sir Roderick Murchison as consisting of porous loose gravel.[1] Mr. Binney has also described the shell-bearing strata associated with Boulder-clays, as these occur on the Lancashire coast, in the neighbourhood of Blackpool.[2] He mentions the association of flint-pebbles with these strata, and he gives a list of the shells, there being eleven forms of univalves, and eight forms of bivalves appertaining to species, all of which are found in the adjoining sea.

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[1] Quart. Journal of the Geol. Soc., Vol. xx

[2] Quart. Journal of the Geol. Soc., vol. xx

In the north-east of Scotland there are, in many spots, strata which seem to have a great affinity to the shell-bearing sands and gravels of Ireland, and to those of opposite districts of England and Wales. Before, however, we can determine the exact position of these Scottish beds, it will be necessary to know somewhat more about them. On the southern side of the Moray Firth, some of these deposits occur, and they have been described by Mr. Jamieson.[3]

In some cases the Aberdeenshire sands and gravels appear to be very nearly allied to the "Manure gravels" of the County of Wexford in their contour, for they occur in the parishes of Cruden and Slains in the form of mounds. They consist of water-worn pebbles, gravels, and sands, with broken shells, among which are fragments of *Cyprina Islandica*, the form most common in the sands and gravels near Carrick-mines, on the south side of Dublin Bay. These sands and gravels of Aberdeenshire have in some instances large erratic blocks resting on them, and sometimes a red clay hides them from view.

Strata of the same character as those of Aberdeenshire have been described by Mr. Prestwich as occurring on the south side of the Moray Firth, near Gamrie.[4] A section of these strata is seen on the coast; and Mr. Prestwich observes that flint-pebbles are found abundantly on the beach, which seem to have been derived probably from the upper beds of sand and gravel which here also afford shells; the species of Molluscs which occur in these sands and gravels, like those from the deposits of Lancashire and Cheshire, are not of a peculiarly Arctic type.

The county of Caithness, in the neighbourhood of Wick, appears likewise to furnish beds having the same position as those on the south side of the Moray Firth. Shells have also been collected from these strata by Mr. Peach.[5] Among the pebbles which enter into the composition of the shell-bearing deposits of Caithness, Mr. Peach mentions the occurrence of chalk flints as not uncommon.

The shells from these Caithness beds have been determined by Mr. Gwyn Jeffreys; and although they contain a few Arctic types, they are, on the whole, forms which have a wide geographical distribution.

[1] Silurian System. page 534.

[2] Mem. of the Lit. and Phil. Society of Manchester. Vol. x. page 121, *et seq.*

[3] Quart. Journal of the Geological Society 1858, page 523.

[4] Trans. of the Geol. Soc. Vol v., p. 147. New series.

[5] Brit. Association Reports, 1862, 1864, and 1866.

Mr. Jamieson has also described the beds which yield shells in Caithness.[1] These beds, he states, consist of dark pebbly silt, or stratified pebbly clay, or gritty mud, and they are generally succeeded by reddish brown stony clay, possessing the ordinary characters of Boulder-clay. The strata in which the shelly fragments are most abundant are sometimes seen resting on the Old Red Sandstones, and the surfaces on which they repose frequently exhibit well marked glacial striation.

A list of shells, by Mr. Gwyn Jeffreys, is appended to Mr. Jamieson's memoir, and this list contains seventy-five species. Few of these shells are purely Arctic forms; and, taking the molluscs collectively from the Caithness beds, they exhibit a much less Arctic facies than those from some other localities in Scotland, among which is Gamrie.

With reference to the strata in the west of Scotland which have been so prolific in shells, and to which the attention of geologists was first directed by the researches of the late Mr. Smith, of Jordan Hill, these seem to possess very marked features which serve to distinguish them from the shelly sands and gravels above alluded to; and these west of Scotland strata also appear to occur in a different horizon.

They are seen in the form of stratified beds which *overlie* the Boulder-clay, and they never appear with Boulder-clay above them. They bear about them, much more decidedly than the "Manure gravels," or their British equivalents, the impress of an Arctic climate. The west of Scotland shell-bearing strata belong to a more recent portion of the Pleistocene period than the beds of England, Wales, or Ireland, which contain shells and flint pebbles; for a well developed mass of Boulder-clay separates the two series from one another.

In England, the district which probably exhibits these shelly sands and gravels, with flint pebbles, in the greatest perfection, is the county of Norfolk; and the relations of these strata to the deposits above and below them in this county, have been well described by Messrs. Prestwich, Searles Wood, jun., F. W. Harmer, and J. E. Taylor. In some portions of this area, reposing upon the Norwich Crags, are grey sands with quartzose and flint gravels, from which Mr. Harmer has obtained, at Belaugh and Weybourne, a large number of shells, amongst which *Tellina solidula* is specially abundant.[2] These grey sands and gravels are succeeded by the lower Boulder-clay (Brick-earth) containing travelled and striated blocks. The fauna of this Boulder-clay is marked by an absence of all the mollusca of the Crags, except such forms as are of an Arctic or Boreal type. In position, this deposit seems to correspond with the Boulder-clay underlying the shell-bearing beds at Howth. At Howth, however, and elsewhere in Ireland, there have as yet been discovered no deposits which can be correlated with the grey sands and gravels that in Norfolk underlie the lower Boulder-clay. The lower Boulder-clays of Norfolk are succeeded by the "middle sands and gravels," which frequently attain a thickness of from 50 to 60 feet. These middle sands and gravels have yielded twenty-three species of shells. Amongst them is *Pectunculus glycimeris*, a form which Mr. Harmer says dies out in the newer part of the Red Crag, which is exceedingly rare in the Norwich Crags, but which is abundant in the middle sands and gravels. *Pectunculus glycimeris*, in a fragmentary state, is one of the most abundant of the bivalves at Pulregan, in the "Manure gravels" of the Co. of Wexford. Mr. Harmer also states that *Ostrea edulis* occurs in the "middle sands and gravels." This form disappears from the newer Crag beds, is not known to live within the Arctic circle; and the character of the fauna of the "middle sands and gravels" is decidedly less Arctic than that of the lower Boulder-clays.

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[1] Quart. Journal of the Geol. Soc., Vol. xxii., p. 261, *et seq.*

[2] GEOLOGICAL MAGAZINE, Vol. VI., page 232.

The middle sands and gravels of Norfolk, like the shell-bearing beds in some portions of Ireland, are succeeded by an upper Boulder-clay, which possesses features showing that it originated, like the lower Boulder-clay, from Arctic conditions.

Judging from the fauna afforded by the three deposits, the lower Boulder-clay, the middle sands and gravels, or their representatives elsewhere in Britain or in Ireland, and the upper Boulder-clay, we arrive at the conclusion, that while, on the whole, there are distinct indications of the prevalence of Arctic conditions, there was, during the deposition of the middle portion of the Pleistocene deposits, a less rigorous climate.

There is another interesting circumstance in connection with the middle Pleistocene strata. This is the almost constant presence of chalk flints among the gravels which belong to this series. In the case of these deposits, as they are seen in the south-west of Ireland, there are at present no Cretaceous rocks nearer than the Co. of Antrim, which is at least 200 miles distant in a direct line from some of the spots where the middle Pleistocene strata are found. A transportation of flint-pebbles from Antrim would imply the agency of a northern current, a circumstance somewhat hostile to the evidence which the fauna of the "Manure gravels" affords; telling us, as it does, of a less rigorous climate than that which marks the earlier and later portions of the Pleistocene epoch.

South-eastern currents probably have had more influence in the transportation of these chalk flints, and they may perhaps have been derived from some source which extended from England to France before the greater portion of St. George's Channel was hollowed out; or before the Straits of Dover were formed.

The various members of the Pleistocene series have sustained, at different times, great losses from denudation.

In many cases the lower Boulder-clay is altogether absent. This is seen in some instances in Norfolk, where the middle sands and gravels repose upon the Crag group. At Moel Tryfaen the shell-bearing sands and gravels occur under somewhat similar conditions, as they rest upon the Cambrian rocks; and it is also probable that the inferior member of the Pleistocene series, the lower Boulder-clay, is absent in the county of Wexford, having been removed by denudation.

The middle sands and gravels of Norfolk, have also been subjected to denuding influences. It is, however, in the south-east of Ireland, that this member of the series exhibits the influence of denudation in a high degree. Here the rounded outline of these deposits is the result of this influence; and here too we have evidence justifying the conclusion that the upper Boulder-clays have to a very great extent been removed by this cause, since we have this upper portion of the series preserved in a few localities only.

No doubt very considerable changes have been effected in the several deposits which constitute the Pleistocene group, since the period of their deposition, by the agency of atmospheric causes. These causes fail, however, to account for the entire absence of one or other member of the group in some localities; and it seems much more probable that the influences of marine currents, during changes in the relative level of land and sea, were the denuding agents, rather than atmospheric causes, such as are now in operation over the several areas where the Pleistocene deposits occur.

V.—ADDITIONS TO THE LIST OF BRACHIOPODA OF THE BRITISH SECONDARY ROCKS.

By RALPH TATE, Assoc. Lin. Soc., F.G.S.

SIXTEEN years have now passed since Mr. Davidson's Mono- graph of the British Secondary Brachiopoda appeared, and as numerous additions have been made from time to time, it is my present object to collate the scattered records of the additional species, and to supplement such information by notices of new or little known forms.

PART I.—LIASSIC SPECIES.

The number of British Liassic Brachiopoda known to Mr. David- son was forty; of these *Leptæna granulosa* is now considered to be *Placunopsis*, *L. Pearcei* is referred to the genus *Monotis*; *Discina Townshendi* finds a habitat in the Rhætic series, and *Discina* and *Lingula Beanii* should be removed to the Inferior Oolite; this number has been greatly augmented, chiefly by the researches of Mr. Charles Moore. The fact of such a large number of species having been overlooked finds an explanation in the greater ber of workers upon the Liassic formations; this is true not for the Brachiopoda, but for other forms of animal life; thus the fauna of the Lias numbers 1,103 species, whereas 426 species are catalogued by Professor Morris in his second edition of Bri Fossils, published 1854. The Lower Lias, which was some characterized by a paucity of Brachiopodous shells—two or species only being well known, has now yielded eighteen species.

1. WALDHEIMIA PERFORATA, Piette, sp. Bull. Soc. Géol. vol. xlii., 1856. Terebratula *strangulata*, Martin. *T.* Quenstedt.

This neat shell is distinguished by its slight subpentagonal form and small umbo; its nearest ally is *W. indentata.* *W. perforata* has been long known in Great Britain; Portlock confounded it with *Terebratula ornithocephala.* In the Bristol Museum, I found it in 1860 labelled *T. punctata*, with which species it has more frequently been confounded.

On the Continent it ranges throughout the Lower and Middle Lias, but appears to be most abundant in the inferior part of the Lower Lias; its distribution in this country is much the same.

Ammonites angulatus zone. Island Magee and Glenarm, Co. Antrim (Tate).

A. Bucklandi zone. Horfield, Ashley, Bedminster, Keynsham (Tate), and Salford (Wright) near Bristol; Camerton, Shepton Mallet (Moore); Wells (Brodie).

Belemnites acutus zone. Ballintoy, Co. Antrim (Tate).

Am. spinatus zone. Wellingore Cutting, Lincolnshire (Judd).[1]

2. TEREBRATELLA LIASINA, Deslongchamps (1853) id. Mem. Soc. Lin. de Normandie (1856).

3. MEGERLIA PERRIERI, Deslong.

4. MEGERLIA SUESSII, Deslong.

The three last species, with some others which characterize the remarkable deposit in the Middle Lias at Fontaine-Etoupe-four, Normandy, were discovered by Mr. C. Moore, at Whatley, near Frome.

5. ZELLANIA OBESA, Moore. Quart. Journ. Geol. Soc., vol. xxiii., p. 240. Lower Lias (zone of *Am. angulatus?*), Stout's Hill (Moore).

Zellania Laboucheri (Moore) and *Z. Davidsoni* (Moore) have occurred to Mr. Moore in the Lower Lias, Brocastle, etc., as well as in the Inferior Oolite.

6. KINGENA? DESLONGCHAMPSI, Davidson (Terebratula). An. Mag. Nat. Hist., vol. v., pl. 15, f. 6 (1850). Middle Lias, Whatley (Moore).

THECIDIUM TRIANGULARE D'Orbigny. This species till recently was only known in the Inferior Oolite, but Mr. C. Moore records it from the Lower Lias of Brocastle, Keynsham, etc.; the Middle Lias Ilminster; Upper Lias, Charter House mine; Fuller's Earth, Comb Down, Bath; and from the Coral Rag.

7. THECIDIUM GRANULOSUM, Moore. Trans. Nat. Hist. Soc., Somersetshire, 1854, p. 13, t. 2, f. 1-6. Middle Lias, Whatley, and Inferior Oolite, Dundry (Moore).

8. THECIDIUM SUBSERRATUM, spec. nov. Shell subquadrangular, attached by the whole of the lower surface of the ventral valve, the front of which is much elevated; area triangular, narrow, hinge line long and straight. Dorsal valve convex smooth, inflated at the umbo, interior with a plain border, within which is a raised serrated margin, from which arises a longitudinal medial lanceolate septum,

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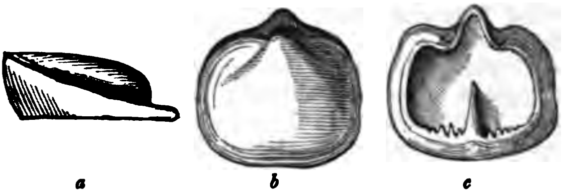
[1] *Waldheimia Mariæ, d'Orb*, regarded by Mr. Davidson as a variety of *W. cornuta*, is described as a distinct species by E. Deslongchamps Pal. Fr. t. 20, f. 1-7; it occurs in the Marlstone of Ilminster.

occupying two-thirds the length of the shell; the muscular depressions are smooth (?).

Thecidium subserratum, sp. nov.



a. Shell seen in profile.
b. Perfect shell, showing exterior of dorsal valve, etc.
c. Interior of dorsal valve.

This species is related to *T. rusticum*, *T. granulosum*, and *T. triangulare*, but presents a combination of characters which distinguishes it from them. Locality, Brocastle (zone of *Am. angulatus*). Possibly *T. triangulare*, Moore (apud D'Orbigny), from the same beds, belongs here. Lower Lias (zone of *Am. angulatus*), Brocastle (Tate).

9. SPIRIFERINA OXYPTERA, Buvignier. Mem. de la Soc. Philom. de Verdun, vol. ii., p. 14, t. 8, f. 8 (1843). Lower part of Middle Lias, Mull. (Geikie).

10. SPIRIFERINA VERRUCOSA, De Buch (*Delthyris*). Petrif. remark. t. 7, f. 2 (1831).

This species, included by Mr. Davidson under *S. rostrata*, is now regarded by most palæontologists as distinct. It characterizes the zone of *Ammonites Jamesoni*, and is found at Cheltenham, Aston, etc., in North Gloucestershire. Middle Lias, Radstock, &c. Though ranging throughout the upper part of the Lower Lias in Germany and France, it has not yet been met with in beds of that formation in this country.[1]

11. SPIRIFERINA DESLONGCHAMPSI, Davidson. An. Nat. Hist. (1862), t. 15, f. 4. Middle Lias, Whatley (Moore).

12. SPIRIFERINA OXYGONA, Deslongchamps. Bull. Soc. Lin. de Normandie, t. 3, f. 5-10 (1858). Middle Lias, Whatley (Moore).

13. SUESSIA IMBRICATA, Deslongchamps. Annuaire l' Institut des Provinces, t. 1, f. 12-16 (1855).

This genus was, until Mr. Moore's discovery, unknown in British strata. Middle Lias, Whatley (Moore).

14. LEPTÆNA ROSTRATA, Deslong. Annuaire l'Inst. des Provinces, t. 1, f. 17-18 (1855). Middle Lias, Whatley and Munger (Moore).

15. RHYNCHONELLA PLICATISSIMA, Quenstedt sp. Handb. Petref., t. 36 (1852).

R. anceps, pars Chapuis and Dewalque (1854).

R. costellata, Piette (1856).

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[1] According to E. Deslongchamps, three varieties of *S. rostrata*, described by Mr. Davidson, are distinct species, and are respectively named *S. Hartmanni*, Ziet, *S. pinguis*, Ziet, and *S. ascendens*, E. Deslong; they occur in the Marlstone of Somersetshire.

R. variabilis (pars), Auctorum Anglicorum.

This species can readily be distinguished from *R. variabilis*, Schloth., with which it appears to have been confounded in this country, by its numerous ribs, twenty-five or so in number. In Germany, France, and Britain, it ranges throughout the Lower Lias; and is very abundant in the *Bucklandi* limestones in the West of England, as at Horfield, Ashley, Keynsham, near Bristol; Badgsworth, Cheltenham (Tate); Evercreach, near Bruton (Holl).

16. RHYNCHONELLA OXYNOTI, Quenstedt sp. Handb. Petref, t. 36, f. 4-5 (1852). *Terebratula Maceana*, D'Orbigny Prodr., p. 221 (1850). *Rhynchonella Buchii*, Chapuis and Dewalque (1854). *Rhynchonella ranina*, Suess (1860).

This species is not so clearly distinguishable from *R. variabilis* as *R. plicatissima*, though it does not apparently graduate into it; and the fact of its occurrence on the same horizon in France, England, and Germany induces one to regard it for the present as a distinct species.

R. oxynoti was found by Oppel in the zone of "Am. oxynotus" in Gloucestershire.

17. RHYNCHONELLA EGRETTA, Deslongchamps. Bull. Soc., Lin. de Normandie, vol iii., t. 4, f. 4-6 (1858).

18. RHYNCHONELLA SUBSERRATA, Munster; R. FALLAX. Deslong. id. vol. vii., t. 3, f. 1-5 (1863).

Both species recorded by Mr. Moore from the Middle Lias, Whatley.

19. RHYNCHONELLA CORONATA (Moore), Geologist, 1861, t. 2, f. 23. Upper Lias, Ilminster.[1]

20. RHYNCHONELLA JURENSIS, Quenstedt (*Terebratula*), Jura, t. 41, f. 33-35.

Mr. Lycett (Proc. Cotts. Club, vol. ii., p. 142. 1860.) records a variety of the above species from the Upper Zone of the Supra Liassic Sands, and also a variety of *R. plicatella*, Sow., from the Lower Zone.

21. CRANIA GUMBERTI, Deslong., loc. cit. vol. vii., t. 3, f. 6–10. Middle Lias, Whatley (Moore).

22. CRANIA LIASSICA, Moore. Quart. Journ. Geol. Soc., vol. xxiii., p. 539. 1867. Lower Lias (Zone of *Am. angulatus*), Brocastle, Stout's Hill.

23. DISCINA HOLDENI, Tate. Quart. Journ. Geol. Soc., vol. xxiii., p. 314 (Nov., 1867).

Ranges from the Zone of "*Am. angulatus*" to that of "*A. Ibex*" in England and Ireland, and throughout the Lower Lias in the east of France.

24. DISCINA ORBICULARIS, Moore. Quart. Journ. Geol. Soc., vol. xxiii., p. 540 (Dec., 1867). Possibly is the young of *D. Holdeni*. Lower Lias, Shepton, Southerndown, and Bedminster.

25. DISCINA DAVIDSONI, Moore. Geologist, 1861, t. 2, f. 16-18,

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[1] Mr. Moore records *R. subtetrahedra*, Davids., in the Marlstone of Ilminster; *R. subvariabilis*, in the Middle Lias, Holwell; and *R. concinna*, in the Middle Lias, Camerton. I regard these as doubtful determinations.

TABLE SHOWING DISTRIBUTION OF BRITISH LIASSIC BRACHIOPODA.

*** Indicates the occurrence in strata representing the whole or part of the Lower Lias above the Bucklandi beds.**

	Am. planorbis.	Am. angulatus.	Am. Bucklandi.	Am. Turneri.	Am. obtusus.	Am. oxynotus.	Am. raricostatus.	Am. Jamesoni.	Am. Ibex.	Am. capricornus.	Am. margarit.	Am. spinatus.	Am. bifrons.	Am. Jurensis.	Am. opalinus.	Passing to Oolitic strata.
CRANIA—																
Gumberti, Deslongchamps...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
liassica, Moore	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...
DISCINA—																
Davidsoni, Moore	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
Holdeni, Tate	...	×	×	...	...	...	...	×	×	...	...	...	...	...	...	...
lævis, Sowerby	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
orbicularis, Moore	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
papyracea, Munster	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
LEPTÆNA—																
Bouchardi, David.	...	...	...	...	...	...	...	...	...	×	×	...	×	...	...	...
Davidsoni, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	×	...	...	...
liasina, Bouchard	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
rostrata, Deslong.	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...
LINGULA—																
Longovicensis, Terq.	...	...	...	...	...	...	...	...	...	...	...	...	×?	...	...	...
Davidsoni, Oppel	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
Metensis, Terquem	...	×	...	*	*	*	×	...	...	...	...	...	...	...	...	...
Voltzii, Terquem	...	...	...	...	...	...	...	...	...	×	?	...	...	...	...	...
MEGERLIA—																
Perrieri, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Suessi, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
RHYNCHONELLA—																
acuta, Sow.	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
Bouchardi, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...
cynocephala, Richard	...	...	...	...	...	...	...	...	...	...	...	×	...	×	×	...
egretta, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
furcillata, Theod.	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×	...
Lycetti, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	×	×	×	?	...
coronata, Moore	...	...	...	...	...	...	...	...	...	...	...	...	...	×	?	...
plicatissima, Quenst.	×	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
pygmæa, Morris	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
oxynoti, Quenstedt	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
serrata, Sow.	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
rimosa, Buch.	...	...	...	...	...	...	...	×	×	×	×	...	...	...	...	...
subconcinna, Davidson ...	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
subserrata, Munst.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
tetrahedra, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
variabilis, Schloth.	...	...	...	...	...	×	×	×	×	×	×	...	...	...	...	...
Jurensis, Quenstedt, var. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...
plicatella, Sow., var.	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	×

	Am. planorbis.	Am. angulatus.	Am. Bucklandi.	Am. Turneri.	Am. obtusus.	Am. oxynotus.	Am. raricostatus.	Am. Jamesoni.	Am. Ibex.	Am. capricornus.	Am. margarit.	Am. spinatus.	Am. bifrons.	Am. Jurensis.	Am. opalinus.	Passing to Oolitic strata.
Spiriferina—																
Deslongchampsi, Davidson...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Ilminsteriensis, Davidson ...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Münsteri, Davidson	...	...	...	...	...	...	...	...	...	...	×	...	×	...	...	...
oxygona, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
oxyptera, Buvignier	...	...	..	...	...	...	...	...	...	×	...	...	...	...	...	...
rostrata, Schloth.	...	...	...	...	...	..	...	...	...	×	×	×	...	×	...	...
verrucosa, De Buch.	...	...	...	...	...	...	...	×	×	×	...	...	...	...	...	...
Walcotti, Sow.	...	...	×	×	×	×	×	...	...	...	×	×	...	...	...	...
Suessia—																
imbricata, Deslong.	...	...	...	...	..	..	...	...	...	...	×	...	...	...	...	...
Terebratula—																
Edwardsi, Davidson	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
globulina, Davidson	...	..	...	...	...	...	...	...	...	...	...	...	×	...	...	...
punctata, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
subpunctata, Davidson ...	...	...	...	...	...	...	...	...	...	...	×	×	...	×	×	...
Thecidium—																
subserratum, Tate	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bouchardi, Davidson	...	...	...	...	...	...	...	...	...	...	×	...	×	×	×	×
granulosum, Moore	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Deslongchampsi, Davidson...	...	...	...	...	..	...	...	...	...	...	×	...	...	...	...	...
Moorei, Davidson	...	×	...	...	...	...	...	...	...	...	×	×	×	...	...	...
rusticum, Moore	...	×	...	...	...	...	...	...	...	...	×	...	×	...	...	...
triangulare, D'Orb.	...	×	...	...	...	...	...	...	...	...	×	...	×	×	×	×
Terebratulina—																
Deslongchampsi, Davidson...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Terebratella—																
liasina, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Waldheimia—																
cornuta, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
indentata, Sow.	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...
Heyseana, Dunk.	...	...	...	...	...	...	...	?	×	...	...	...	...	...	...	...
Lycetti, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...
Moorei, Davidson	...	...	...	...	...	...	.	...	...	...	×	×	...	...	...	...
numismalis, Lamk.	...	...	...	...	...	×	×	×	×	×	×	×	...	...	...	...
perforata, Piette	...	×	×	●	●	●	●	...	...	...	...	×	...	...	...	...
quadrifida, Lamk.	...	...	...	..	...	...	...	...	...	...	×	×	...	..	...	...
resupinata, Sow.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
subovoides, Rom.	...	...	...	...	...	...	...	×	×	..	...	...	...	...	...	...
subnumismalis, Davidson ...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Waterhousei, Davidson ...	...	...	...	...	...	..	...	?	×	×	...	×	...	...	...	...
Zellania—																
Davidsoni, Moore	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	×
liasina, Moore	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Laboucheri, Moore	...	×?	...	...	...	...	...	...	...	...	...	...	...	...	...	×
obesa, Moore	..	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total species 76	1	13	5	3	3	7	5	10	9	14	37	19	23	12	7	5

TABLE SHOWING DISTRIBUTION OF BRITISH LIASSIC BRACHIOPODA.

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	Am. planorbis.	Am. angulatus.	Am. Bucklandi.	Am. Turneri.	Am. obtusus.	Am. oxynotus.	Am. raricostatus.	Am. Jamesoni.	Am. Ibex.	Am. capricornus.	Am. margarit.	Am. spinatus.	Am. bifrons.	Am. Jurensis.	Am. opalinus.	Passing to Oolitic strata.
Crania—																
Gumberti, Deslongchamps	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
liassica, Moore	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...
Discina—																
Davidsoni, Moore	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
Holdeni, Tate	...	×	×	...	...	...	...	×	×	...	...	...	...	...	...	...
lævis, Sowerby	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
orbicularis, Moore	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
papyracea, Munster	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Leptæna—																
Bouchardi, David.	...	...	...	...	...	...	...	...	...	×	×	...	×	...	...	...
Davidsoni, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	×	...	...	...
liasina, Bouchard	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
rostrata, Deslong.	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...	...
Lingula—																
Longovicensis, Terq.	...	...	...	...	...	...	...	...	...	...	...	...	×?	...	...	...
Davidsoni, Oppel	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
Metensis, Terquem	...	×	...	*	*	*	×	...	...	...	...	...	...	...	...	...
Voltzii, Terquem	...	...	...	...	...	...	...	...	...	×	?	...	...	...	...	...
Megerlia—																
Perrieri, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Suessi, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Rhynchonella—																
acuta, Sow.	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
Bouchardi, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...
cynocephala, Richard	...	...	...	...	...	...	...	...	...	...	...	×	...	×	×	...
egretta, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
furcillata, Theod.	...	...	...	...	...	...	...	×	×	×	×	×	×	×	×	...
Lycetti, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	...	×	×	×	?	...
coronata, Moore	...	...	...	...	...	...	...	...	...	...	...	...	...	×	?	...
plicatissima, Quenst.	×	×	×	...	...	...	...	...	...	...	...	...	...	...	...	...
pygmæa, Morris	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
oxynoti, Quenstedt	...	...	...	...	...	×	...	...	...	...	...	...	...	...	...	...
serrata, Sow.	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
rimosa, Buch.	...	...	...	...	...	...	...	×	×	×	×	...	...	...	...	...
subconcinna, Davidson	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
subserrata, Munst.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
tetrahedra, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
variabilis, Schloth.	...	...	...	...	...	×	×	×	×	×	×	...	...	...	...	...
Jurensis, Quenstedt, var.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...
plicatella, Sow., var.	...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	×

	Am. planorbis.	Am. angulatus.	Am. Bucklandi.	Am. Turneri.	Am. obtusus.	Am. oxynotus.	Am. raricostatus.	Am. Jamesoni.	Am. Ibex.	Am. capricornus.	Am. margarit.	Am. spinatus.	Am. bifrons.	Am. Jurensis.	Am. opalinus.	Passing to Oolitic strata.
SPIRIFERINA—																
Deslongchampsi, Davidson...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Ilminsteriensis, Davidson ...	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Münsteri, Davidson	...	...	...	...	...	...	...	...	...	...	×	...	×	...	...	...
oxygona, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
oxyptera, Buvignier	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...	...
rostrata, Schloth.	...	...	...	...	...	...	...	...	...	×	×	×	...	×	...	...
verrucosa, De Buch.	...	...	...	...	...	...	...	×	×	×	...	...	...	...	...	...
Walcotti, Sow.	...	...	×	×	×	×	×	...	...	...	×	×	...	...	...	...
SUESSIA—																
imbricata, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
TEREBRATULA—																
Edwardsi, Davidson	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
globulina, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
punctata, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
subpunctata, Davidson ...	...	...	...	...	...	...	...	...	...	...	×	×	...	×	×	...
THECIDIUM—																
subserratum, Tate	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bouchardi, Davidson	...	...	...	...	...	...	...	...	...	...	×	...	×	×	×	×
granulosum, Moore	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Deslongchampsi, Davidson...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Moorei, Davidson	...	×	...	...	...	...	...	...	...	...	×	×	×	...	...	...
rusticum, Moore	...	×	...	...	...	...	...	...	...	...	×	...	×	...	...	...
triangulare, D'Orb.	...	×	...	...	...	...	...	...	...	...	×	...	×	×	×	×
TEREBRATULINA—																
Deslongchampsi, Davidson...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
TEREBRATELLA—																
liasina, Deslong.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
WALDHEIMIA—																
cornuta, Sow.	...	...	...	...	...	...	...	...	...	×	×	×	...	...	...	...
indentata, Sow.	...	...	...	...	...	...	...	×	...	...	...	...	...	...	...	...
Heyseana, Dunk.	...	...	...	...	...	...	...	?	×	...	...	...	...	...	...	...
Lycetti, Davidson	...	...	...	...	...	...	...	...	...	...	...	...	×	×	...	...
Moorei, Davidson	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
numismalis, Lamk.	...	...	...	...	...	×	×	×	×	×	×	×	...	...	...	...
perforata, Piette	...	×	×	●	●	●	●	...	...	...	...	×	...	...	...	...
quadrifida, Lamk.	...	...	...	...	...	...	...	...	...	...	×	×	...	...	...	...
resupinata, Sow.	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
subovoides, Rom.	...	...	...	...	...	...	...	×	×	...	...	...	...	...	...	...
subnumismalis, Davidson ...	...	...	...	...	...	...	...	...	...	...	×	...	...	...	...	...
Waterhousei, Davidson ...	...	...	...	...	...	...	...	?	×	×	...	×	...	...	...	...
ZELLANIA—																
Davidsoni, Moore	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	×
liasina, Moore	...	...	...	...	...	...	...	...	...	...	...	...	×	...	...	...
Laboucheri, Moore	...	×?	...	...	...	...	...	...	...	...	...	...	...	...	...	×
obesa, Moore	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total species 76	1	13	5	3	3	7	5	10	9	14	37	19	23	12	7	5

Cosmolepis, Ag.
— *Egertoni*, Ag., M. G. S., Dec. 9, pl. 1, fig. 1.
Ctenacanthus, Ag.
— *nodosus*, Eg., J. G. S., vol. 9, p. 281.
Ctenopetalus, Ag., *Mss.* (Petalodus, Owen. Ctenoptychius, Ag.).
— *serratus*, Ag., P. F., tom. 3, feuil. 173.
Cyclurus, Ag.
— *minor*, Ag., P. F., tom. 5, tab. 53, fig. 1.
Dapedius, De la Beche.
— *Colei.*, Ag., P. F., tom. 2, tab. 25*b*.
Deltodus, Ag., *Mss*, June 27, 1859.
— *sublævis*, Ag. (Pœcilodus), P. F., tom. 3, feuil. 174 (P. parallelus).
Deltoptychius, Ag., *Mss.* (Cochliodus, Ag.).
— *acutus*, Ag., P. F., tom. 3, feuil. 104.
— *gibberulus*, Ag., *Mss.*, June 27, 1859.
Diodon, Linn.
— *erinaceus*, Ag., P. F., tom. 2, pt. 2, feuil. 274.
— *Scillæ*, Ag., P. F., tom. 2, pt. 2, feuil. 274.
Dimyleus, Ag., *Mss.* (Psammodus, Ag.).
— *Woodi*, Ag., *Mss.*, June 27, 1859.
Eugnathus, Ag.
— *chirotes*, Ag., P. F., tom. 2, tab. 57*b*.
— *polyodon*, Ag., P. F., tom 2, pt. 2, feuil. 104.
Ganodus, Eg.
— *emarginatus*, Eg., P. F., tom. 3, feuil. 345.
Glyptolepis, Ag.
— *leptopterus*, Ag., P. F. V. G. R., tab. 20, fig. 1.
— ,, ,, P. F. V. G. R., tab. 20, fig. 5. *(Counterpart.)*
— ,, ,, P. F. V. G. R., tab. 21, fig. 2. *(Counterpart.)*
— ,, ,, P. F. V. G. R., tab. 21, fig. 3.
Gyrodus, Ag.
— *Murchisoni*, Mant. Medals of Creation, vol. 2, pl. 134.
— *perlatus*, Ag., P. F., tom. 2, pt. 2, feuil 236.
— *trigonus*, Ag., P. F., tom. 2, tab. 69*a*, fig 15.
Harpacodus, Ag., *Mss.*, June 27, 1859 (Ctenoptychius, Ag.)
— *dentatus*, Ag. P. F. tom. 3, feuil. 173
Heterolepidotus, Eg. (Eulepidotus, Eg. Lepidotus, Ag.)
— *sauroides*, Eg., J. G. S., 1868, p. 503.
— ,, Eg., J. G.. S., 1868, p. 503.
— *serrulatus*, Ag. (Lepidotus), P. F., tom. 2, tab. 31.
Holophagus, Eg.
— *gulo*, Eg., J. G. S., 1868, p. 502.
Hybodus, Ag.
— *carinatus*, Ag., P. F., tom. 3, tab. 9, figs. 13–14.
— *complanatus*, Owen. Geol. Mag. 1869, tom. 6, No. 11, P. 482.
— *crassispinus*, Ag., P. F., tom 3, tab. 8*b*, fig. 7.
— *dorsalis*, Ag., P. F., tom. 3, tab. 10, fig. 1.
— *grossiconus*, Ag., P. F., tom. 3, tab. 23. figs. 34–40–41.
— *marginalis*, Ag., P. F., tom. 3, tab. 10, fig. 18.
— *minor*, Ag., P. F., tom. 3, tab. 23, figs. 21–23.
— *reticulatus*, Ag. (H. curtus Ag.) P. F., tom.. 3., tab. 8*a*, fig. 5.
Isocolum, Eg.
— *granulatum*, Eg., J. G. S., 1868, p. 501.
Isurus, Ag.
— *macrurus*, Ag., P. F., tom. 5, tab. 21, fig. 3.
Labodus, Ag., *Mss.*, (Psammodus cornutus, Ag.)
— *planus*, Ag., *Mss.*, June 27, 1859.
— *prototypus*, Ag., *Mss.*, June 27, 1859.
Lepidotus, Ag.
— *minor*, Ag., P. F., tom. 2, tab. 29*c*, fig. 12.
— *palliatus*, Ag., P. F., tom. 2, tab. 29*c*, fig. 2.
— ,, P. F., tom. 2, tab. 29*c*, fig. 3.
— *pectinatus*, Eg., M. G. S., Dec. 6, pl. 3.

Lepracanthus, Eg.
— *Colei*, Eg., P. F., tom. 3, feuil 177, and Geol. Mag. 1869, tom. 6, No. 11, P. 481.
Leptacanthus, Ag.
— *semistriatus*, Ag., P. F., tom. 3, tab. 7, fig. 6.
— *serratus*, Ag., P. F., tom. 3, tab. 7, fig. 1.
— *tenuispinus*, Ag., P. F., tom. 3, tab. 1*a*, figs. 12–13.
Leuciscus, Klein.
— *macrurus*, Ag., P. F., tom. 5, tab. 51*b*, fig. 3.
Megalurus, Ag.
— *Damoni*, Eg., M. G. S., Dec. 9, pl. 8, fig. 2.
Mesogomphus, Ag., *Mss.* (Psammodus cornutus, Ag.)
— *lingua*, Ag., *Mss.*, June 27, 1859.
Mylacodus, Ag., *Mss.* (Psammodus cornutus, Ag.)
— *quadratus*, Ag., *Mss.*, June 27, 1859.
Mylax, Ag., *Mss.* (Psammodus cornutus, Ag.)
— *batoides*, Ag., *Mss.*, June 27, 1859.
Myliobates, Dumeril.
— *goniopleurus*, Ag., P. F., tom. 3, tab. 47, figs. 9–10.
— *Toliapicus*, Ag., P. F., tom. 3, tab. 47, figs. 15–16.
Myriacanthus, Ag.
— *granulatus*, Ag., P. F., tom. 3, tab. 8*a*, fig 16.
— *paradoxus*, Ag., P. F., tom. 3, tab. 6, fig. 5.
Nemopteryx, Ag.
— *crassus*, Ag., P. F., tom. 5, tab. 22 *(Counterpart).*
— *elongatus*. Ag., P. F., tom. 5, tab. 21*a*, fig. 2 *(Counterpart).*
Orodus, Ag.
— *ramosus*, Ag., P. F., tom. 3, tab. 11, figs. 5–6.
Osmerus, Arted.
— *Glarisianus*, Ag., P. F., tom. 5, tab. 62, fig. 3.
— ,, Ag., P. F., tom. 5, tab. 62, fig. 4.
Osteorachis, Eg.
— *macrocephalus*, Eg., J. G. S. 1868, p. 500.
— ,, Eg., J. G. S. 1868, p. 500.
Oxygnathus, Eg.
— *ornatus*, Eg., M. G. S., Dec. 8, pl. 9, fig 1.
Pachycormus, Ag.
— *branchialis*, Ag., *Mss.*
— *curtus*, Ag.. P. F., tom. 2, tab. 59 *(Counterpart).*
— *latus*. Ag., P. F., tom 2, pt. 2, feuil. 114.
Palæoniscus, Ag.
— *arcuatus*. Eg., J. G. S., vol. 6, pl. 1, fig. 1.
— *Beaumonti*, Eg., J. G. S., vol. 6, pl. 1, figs. 5, 6.
— *decorus*, Eg., J. G. S., vol 6, pl. 2.
Palæorhynchum, De Blain.
— *Colei*, Ag., P. F., tom. 5, tab. 32, fig. 1.
— *Egertoni*, Ag., P. F., tom. 5, tab. 34*a*, fig. 2 *(Counterpart).*
— *latum*, Ag., P. F., tom. 5, tab. 3[illegible], fig 2.
— *longirostre*, Ag., P. F., tom. 5, tab. 34*a*, fig. 3 *(Counterpart).*
— *microspondylum*, Ag., P. F., tom. 5, tab. 34*a*, fig. 1.
Petalorhynchus, Ag., *Mss.* (Petalodus).
— *psittacinus*. Ag., P. F., tom. 3, feuil 174 (P. sagittatus).
Pholidophorus, Ag.
— *minor*, Ag., P. F., tom. 2, tab. 42*a*, fig. 5.
Phyllodus, Ag.
— *Colei*, Cocchi, Pesch. Lab. Tav. 1*a*, fig. 1.
— *marginalis*, Ag., Pesch. Lab. Tav. 2*a*, fig. 1.
— *medius*, Ag., Pesch. Lab. Tav. 2*a*, figs. 11–11*a*.
— *speciosus*, Cocchi. Pesch. Lab. Tav. 1*a*, fig. 7.
Pinacodus, Ag., *Mss.* (Psammodus cornutus).
— *gelasimus*, Ag.. *Mss.*, June 27, 1859.
— *gonoplax*, Ag., *Mss.*, June 27, 1859.
— *sesamini*, Ag., *Mss.*, June 27, 1859.

PLEUROGOMPHUS, Ag., *Mss.*
— *auriculatus*, Ag. *Mss.*, June 27, 1859.
PŒCILODUS, Ag.
— *Jonesi*, Ag., P. F. , tom, 3, feuil 174 (P. obliquus).
POLYRHIZODUS, McCoy.
— *radicans*, Ag , P. F., tom. 3, feuil 174 (P. etalodus radicans and rectus).
PRISTODUS, Ag., *Mss.*
— *falcatus*, Ag., *Mss.*, June 27, 1859.
PSAMMODUS, Ag.
— *rugosus*, Ag., P. F., tom. 3, tab. 19, figs. 15 *a b c d.*
PSEPHODUS, Ag., *Mss.*, June 27, 1859.
— *magnus*, Ag., P. F., tom. 3, feuil 174 (Cochliodus).
PTERICHTHYS, Ag.
— *cornutus*, Ag., P. F. V. G. R., tab. 2, fig. 2.
— ,, Ag., P. F. V. G. R., tab. 2, fig. 4.
— ,, Ag P. F., V. G. R., tab. 2, fig. 5.
— *productus*, Ag., P. F. V. G. R., tab. 5, fig. 1 *(Counterpart).*
— ,, Ag., P. F. V. G. R., tab. 5, fig. 2.
PTYCHOLEPIS, Ag.
— *Bollensis*, Ag., P. F., tom. 2, tab. 58*b*, figs. 1-2-3.
— *minor*, Eg., M. G. S. Dec. 6, pl. 7, fig. 2.
PYCNODUS. Ag.
— *didymus*, Ag., P. F., tom. 2, tab. 72*a*, figs. 24-25.
— *parvus*, Ag., P. F., tom. 2, pt. 2, feuil. 199.
PYGÆUS, Ag.
— *Coleanus*, Ag., P. F., tom. 4, tab. 44, fig. 5.
— *Egertoni*, Ag., P. F., tom. 4, feuil. 257.
— *gibbus*, Ag., P. F., tom. 4, feuil. 257.
RHYMODUS, Ag., *Mss.* (Psammodus cornutus).
— *transversus*, Ag , *Mss.*, June 27, 1859.
SCOMBRINUS, Ag.
— *nuchlias*, Ag., Rep. Brit. Ass. 1844, p. 307.
SCYLLIODUS, Ag.
— *antiquus*, Ag., P. F., tom. 3, tab. 38, fig. 1 *(Counterpart).*
— ,, Ag., P. F., tom. 3, tab. 38, fig. 2.
SEMIONOTUS, Ag.
— *rhombifer*, Ag., P. F., tom. 2, tab. 26*a*.
— *striatus*, Ag., P. F., tom. 2, tab. 27*a*, fig. 6.
SPHYRÆNODUS, Ag. (Dictyodus, Owen).
— *priscus*, Ag., P. F., tom. 5, tab. 26, figs. 4, 5, 6.
STREBLODUS, Ag., *Mss* (Cochliodus).
— *Colei*, Ag., *Mss.*, June 27, 1859 (Cochliodus oblongus).
— *Egertoni*, Ag., *Mss.*, June 27, 1859 (Cochliodus oblongus).
— *oblongus*, Ag., P. F., tom. 3, feuil. 174 (Cochliodus oblongus).
STROPHODUS, Ag.
— *reticulatus*, Ag., P. F., tom. 3, tab. 17.
TETRAGONOLEPIS, Ag. (not Bronn.), (Œchmodus, Eg.).
— *confluens*, Ag., P. F., tom. 2, tab. 23*a*, fig. 1.
— *leiosomus*, Ag., P. F., tom. 2, tab. 23*a*, fig. 3.
— *pustulatus*, Ag., P. F., tom. 2, 23*c* (Dapedius).
— *speciosus*, Ag., P. F., tom. 2, tab. 23*b*.
THRISSONOTUS, Ag.
— *Colei*, Ag., M. G. S., Dec. 9, pl. 2.
TOMODUS, Ag., *Mss.*
— *convexus*, Ag., *Mss.*, June 27, 1859 (Cochliodus magnus).
XYSTRODUS. Ag., *Mss.* (Cochliodus).
— *augustus*, Ag., *Mss.*, June 27, 1859 (Cochliodus striatus).
— *striatus*, Ag., P. F., tom. 3, feuil. 174 (Cochliodus).

Works referred to in the foregoing Catalogue:
P. F. Recherches sur les Poissons Fossiles, par Louis Agassiz.
P. F. V. G. R. Poissons Fossiles du Vieux Gres Rouge, par Louis Agassiz.

M. G. S. Memoirs of the Geological Survey of Great Britain.
P. G. S. Proceedings of the Geological Society of London.
J. G. S. Journal of the Geological Society of London.
Rep. Brit. Ass. Report of the British Association for the Advancement of Science.
King Perm. Foss. Palæontographical Society, Monograph of the Permian Fossils of England, by William King.
Pesch. Lab. Monographia dei Pharyngodopilidæ Studi Palæontologici del Del. Cav. Prof. Igino Cocchi, 1864.
Dixon, F. S. Fossils of the Tertiary and Cretaceous formations of Sussex, by Frederick Dixon.
Phil. Trans. Philosophical Transactions of the Royal Society.
Geol. Mag. Geological Magazine.

VII.—ON THE OCCURRENCE OF ALBITE IN THE GRANITE OF LEINSTER.

By W. H. STACPOOLE WESTROPP, M.R.I.A.

DURING the past summer, I had the good fortune to detect Albite (Soda-feldspar) in some blocks of granite in the wall of the west pier at Kingstown, Co. Dublin. As the pier is built of rock from the Dalkey quarries, the mineral can be referred, with tolerable certainty, to its original locality. I was induced to look closely at the above-mentioned blocks, through noticing that they contained a mineral of a purple colour; this proved to be fluor, which occurs sparingly throughout the Leinster granite. Associated with the fluor was a pretty considerable quantity of a white mineral, occurring in aggregations of minute crystals; this appeared to me to be so like Albite that I considered it deserving a careful examination. I brought some of it to the Rev. Professor Haughton, F.R.S., who agreed with me in thinking that it had a very albitic look, and kindly undertook to have it analyzed, which has been done with the following result:—

Silica	64·70
Alumina	21.80
Potash	2·84
Soda	9·78
Loss	0·30
	99·42

Unfortunately the quantity which could be separated sufficiently pure for analytical purposes was very small.

This discovery is one of no little interest in the correlation of the irruptive granites of Leinster with those of Mourne and Cornwall.

There can be little doubt but that most, if not all, granite contains a second feldspar in addition to Orthoclase (Potash-feldspar).

The second feldspar that is a constituent of the bedded granites of Connaught, Donegal, parts of Scotland, and Scandinavia, is always oligoclase. The opinion is daily gaining support that these bedded rocks are really of metamorphic origin.

Oligoclase has never been found in irruptive (intrusive) granites, such as those of Leinster, Mourne, Cornwall, and parts of Scotland, but it is not improbable that Albite may be a normal constituent, though not always occurring in the crystalline condition.

It is some years since Professor Haughton, in the first of his well known and invaluable researches in British granites, shewed that the granite of Leinster contains more soda than will satisfy the condition of its having orthoclase as its only feldspar; and in a recent communication to the Royal Society of London, he stated (I quote from memory) that though Albite had never yet been detected in the Leinster granite, its existence could be inferred with considerable probability.

At any time the discovery of this mineral would be of considerable interest, but it is particularly so just now, as it proves the soundness of the conjecture of Professor Haughton, who has done more than any living geologist towards solving the great problem of the origin of granite.

NOTICES OF MEMOIRS.

I.—ABSTRACT OF THE PROCEEDINGS OF THE LIVERPOOL GEOLOGICAL SOCIETY. SESSION THE TENTH, 1868–69.

IN his anniversary address, read before the Liverpool Geological Society on the 13th October, 1868, Mr. R. A. Eskrigge, F.G.S., the retiring President, made a few remarks on the work done by the Society during the past session. They were then entering upon the tenth session, and the number of members, which at first was six, had increased to fifty-six. Still, within the last four years there had been no advance, the withdrawals having slightly exceeded the number of new members. Mr. Eskrigge, however, was inclined to regard the numerical position of the Society as satisfactory, considering the comparatively small attraction presented by the geological features of their immediate neighbourhood. But there was cause for regret and disappointment in noticing how few members took an active part in their Transactions. A meeting of the British Association in Liverpool was anticipated within two or three years, and the President therefore urged them to greater activity, saying that, as on such an occasion prominence would probably be given to the peculiar features of local geology, it behoved the Society to be in readiness for the work which then would fairly devolve upon them.[1]

The volume of Proceedings now before us contains some notes by Dr. C. Ricketts, F.G.S., on the Silurian and Carboniferous rocks in the neighbourhood of Ingleborough. The latter strata repose, except where faulted, in a strictly horizontal position on the highly inclined and contorted Silurian rocks. In the dales, the Carboniferous rocks have been cut through by the action of subaërial denudation, which has exposed and also deeply eroded the older rocks beneath.[2]

Mr. Charles Potter records some observations on the Cheshire Coast. He describes a section of Peat and Silt beds resting on Boulder-clay.

Mr. Robert Bostock contributes a paper on the New Red Sandstone as a source of Water-supply. His remarks refer to the neighbourhood of Liverpool, and he discusses the origin of the supply of water. Mr. Bostock had long thought that more water was raised from the wells of the district in one month than the rainfall would supply in twelve; and, from his observations, it appears to him beyond all doubt that the bulk of the water supply is drawn from the sea.

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[1] The meeting of the British Association in 1870 will be held in Liverpool.

[2] For a detailed description of the Silurian rocks reference is made to a paper by Mr. T. McKenny Hughes in the GEOLOGICAL MAGAZINE for 1867, p. 346.

Mr. H. Hicks, F.G.S., furnishes some notes on the Arenig rocks (or Skiddaw-slates) in the neighbourhood of St. David's. His remarks refer more particularly to a set of beds underlying the true Arenig rock, and which have been termed the Lower Arenig rocks by Mr. Salter and himself. They rest upon, and, indeed, graduate into the Lingula Flags. Their thickness is about 500 feet, and they are invariably rich in fossils; the absence of Graptolites is noteworthy. Up to the present time about twenty new species have been discovered in these beds. The Brachiopoda were described by Mr. Davidson in the Geological Magazine, Vol. V., 1868.

In the Upper or true Arenig rock, Graptolites begin to prevail. These beds are less fossiliferous than the underlying series, and most of the species in the two groups are entirely distinct.

Mr. G. H. Morton brings forward some preliminary observations on the Carboniferous Limestone in Flintshire. When his investigations are completed the detailed results will be communicated to the Society.

Mr. Norman Tate, F.C.S., in an introductory paper on the Chemistry of the primæval earth, lays before the Society some of the more important facts which were touched upon during the late discussion between Dr. Sterry Hunt and Mr. David Forbes, and he also points out some other matters which he thinks should be taken into consideration in studying the subject.

Mr. Isaac Roberts writes on the wells and water of Liverpool. He describes seven wells, and notices the mineral matter contained ni the waters. The observations on the source of the water, lead him to a conclusion similar to that at which Mr. Bostock has arrived, in the paper previously noticed.

The last paper is by Mr. G. H. Morton, F.G.S., etc., on the geology and mineral veins of the country around Shelve, Shropshire, etc. A notice of this appeared in the November number of the Geological Magazine, p. 519.

II.—Report on Mineral Veins in Carboniferous Limestone and their Organic Contents.[1]

By Charles Moore, F.G.S.

Mr. MOORE has for a long time made the phenomena attending Mineral veins in different parts of England, and the Organic remains he has found in them, his special study. In his paper, he first referred to the prevalent ideas which were entertained as to the origin of minerals in veins, some supposing them to be due to sublimation, others to segregation. In the first instance, it is believed, they are due to the passage upwards, through the veins, of vapours holding the minerals from the heated interior of the earth; in the latter that they have been extracted from and drawn together from the matrix forming the walls of the veins, and re-deposited therein. The difficulties attending both these popular ideas were then noticed. Referring to Mr. Wallace's theory, that many of the veins had been filled, and the minerals segregated by atmospheric and hydrous agency from the circulation through them of large bodies of water since the Glacial period, he pointed out that in this case the organic remains in the veins would be comparatively recent, and that the remote age of all the fossils was against it. Mr. Moore's view was, that the mineral veins were at first open fissures, in immediate connexion, and filled with the waters of the ocean; and that there would be necessary for the subsequent deposition of minerals therein, the presence of certain minerals in the ancient seas favourable to electrical conditions, and time for their precipitation; and it was stated to be an established fact that the minerals now found in veins are known to be present in solution in the waters of the ocean. The organic remains he had discovered were strongly confirmatory of his view, and the age of different mineral veins could be determined by their presence. Thus, on the Mendips, Liassic fish and testacea in the veins proved the minerals of that district, although enclosed in walls of Carboniferous limestone, to be as young as the Lias, although no Liassic rocks are to be found for several miles; and, in the North of England, some of the veins were shewn to be subsequent to the coal period. The organic remains which were described at length by Mr. Moore, were of the most varied kinds. *Flemingites gracilis*, a small Lycopodiaceous seed of the Coal-measures, had been found in several mines. *Conodonts* (never before observed above Silurian strata), very minute bodies not unlike fish-jaws and spines, but which were supposed by the author of the paper to be either teeth or spines of Nudibranchiate Mollusca, occurred in the veins in considerable numbers, presenting a most remarkable series of forms; and *Entomostraca* of the genera *Bairdia*, *Beyrichia*, *Cythere*, *Cytherella*, *Kirkbya*, and *Moorea*, of about thirty species. *Foraminifera* were abundant, representing five genera, the chief interest attaching to *Involutina*, of which until lately only one species was known, but of which Mr. Moore had found eleven species. Of this class he had also obtained from the lead veins, species of *Dentalina*, *Textularia*, and *Tinoporus*, which had lived on from the Palæozoic age to the present time. Not the least important of his nine explorations had been the discovery of a land and fresh-water fauna. Until lately, the only known terrestrial shell below the Secondary beds was the *Pupa vetusta*, found by Sir Charles Lyell and Dr. Dawson in the Coal-measures of Nova Scotia, but he had now nine genera of land and fresh-water shells from the lead mines of this country, all of them probably of Carboniferous limestone age. These include *Helix*, *Vertigo*, and *Proserpina* land-shells from the Mendip mines, as well as the fresh-water genera of *Planorbis* and *Valvata*, to which, from the North of England mines, are to be added *Hydrobia*, *Bythinia*, *Lithoglyphus*, and *Pisidium*. Fish remains were often found. Under these peculiar circumstances, from mineral veins and fissures of different ages in the Carboniferous limestone, he had discovered the oldest known Mammalia, about thirty-two species of fish, and eight of Reptilia, the oldest land and fresh-water Mollusca, and numerous other remains, numbering in the whole about 267 species.

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[1] Read before the British Association, Section C., Exeter, August, 1869.

Mr. H. B. Brady, who had made a special examination of the Foraminifera discovered by Mr. Moore, referred to the great interest attaching to the genus *Involutina*, from the remarkable variety of form his series presented, which had not hitherto been recognized in connexion with the genus.

REVIEWS.

I.—MR. WATERHOUSE HAWKINS'S RESTORATIONS OF EXTINCT AMERICAN DINOSAURIA.

"THE Twelfth Annual Report of the Board of Commissioners of the Central Park (New York), for the year ending December 31, 1868," gives an account of the progress in the construction and ornamentation of this well-designed and noble work, which is to comprehend all that is agreeable to the healthy recreation of the citizens and serviceable for their intellectual activity. The landscape-gardener, sculptor, and architect have already been successful in carrying out designs, both of high art and of picturesque rusticity. The Naturalist has his Zoological Garden, which is to be useful also to the Cattle-breeder and the Acclimatization Society. The Botanist, the Astronomer, and the Meteorologist are to find aids here in their researches. The Antiquary and Historian will find a Library and Museum. Nor is Geology lost sight of. The ground itself of the Park is not destitute of geological interest; for the labour of upwards of 200 rockmen and blasters,—required to quarry and cut for ponds, rivulets, and roads,—open out sections worth looking at; but the Commissioners determined to increase the value of the Park in an educational point of view by availing themselves of the scientific assistance of Mr. B. Waterhouse Hawkins, F.G.S., well known as the talented constructor of the restorations of Extinct Quadrupeds at the Crystal Palace, in modelling some of the great American creatures of bygone times, of natural size and in life-like form. This Report tells us of the already successful labours of Mr. B. W. Hawkins, in visiting the Museums at Washington, New Brunswick, Albany, New Haven, and Philadelphia, especially the latter, studying these "rich storehouses of fossil treasures, of special value for the purpose of illustrating the gigantic forms of life that originally inhabited this Continent," and reproducing in iron, plaster, and such like materials, the wonderfully bizarre and, as it were, monstrous Dinosaurian forms, cousin-german to our Iguanodons, Hylæosaurs, Scelidosaurs, Megalosaurs, and other Mesozoic Reptiles.

Mr. Hawkins has chosen for his first American restorations Hadro-

saurus Foulkii (Leidy) and *Lælaps aquilunguis* (Cope). The former, set up as a perfect skeleton, nearly erect on its hind feet and tail-end but resting with its front paws against the upper boughs of a tree, presents a gigantic kangaroo-like outline, with a stature of about eighteen feet. It is characterized by its long, strong, many-jointed tail; its great, long, three-toed hind legs; its short, weak, four-toed front limbs, and its weird, turtle-like, big-eyed skull,—all shown, together with the Restorer, in the photograph at page 138 of this Report. The *Lælaps* figures, both in its fleshless erect skeleton (twenty feet high), and in its rehabilitated form, couchant, are shown in a lithograph opposite page 30. Its longer, hooked, and somewhat bird-like skull, distinguishes this from its brother monster.

The completion of the skeletons, by making good the broken parts, restoring bones of one side by reversed models from the opposite, and replacing strange bones aright in their relative positions, is no small task of science and art; but in setting these bones and joints in the varied conditions of rest and motion, and in covering them with their due envelopes of muscle and integument, the artistic naturalist has had a task equal to his best and boldest efforts; and he fully acknowledges, in his official letters in the Report, that he has worked on the excellent basis afforded by the scientific works of Leidy and Cope (enlightened moreover by Huxley's researches), and that he has throughout received the courteous and cordial co-operation of the savants of the United States. Not only must Mr. Hawkins be gratified in advancing the means of educational progress in America in thus adding to the resources of the Central Park, but he must feel great pleasure in putting bodily before our eyes the definite shapes and proportions of some of the great and long unknown reptilian masters of the world, whether dignified in their monstrous bulk and unused power as Herbivores, or domineering as the Carnivorous tyrants of their day. Showing us, too, how when they rose up like giants refreshed, to prowl among the marshes and mud-banks, or to feed on the dank jungles and marsh-plants, they either stalked erect with upraised head, combining the gait of Ostrich and Kangaroo, and leaving the bipedal trifid tracks so common in our Wealden strata;—or, crawling like a big-legged Labyrinthodont, or somewhat like the Kangaroo, prone on all fours, but making no great leaps, they left quadrupedal print-marks of unequal feet, as still seen in the older Connecticut Sandstone. How far, in other respects besides this upright gait and three-toed hind feet, these ornithico-saurian creatures resembled Birds, palæontologists are making it their study to determine.[1]

We shall indeed look forward with pleasure for other results of Mr. Hawkins' scientific skill; and we shall be very glad to be able to congratulate the Commissioners of the Park on the advancement of all their good intentions and excellent plans for making the Park not only an ornament to their great city, and a healthy recreation-ground to their fellow-citizens, but also a useful, good, and comprehensive educational institution to all who may visit it, gentle and simple, citizen and stranger. We must add that the statistics of the work done in the Park, of its visitors, and of other matters concerning it, speak clearly and satisfactorily of the well-being and advancement of the Americans, of their administrative powers, and of their knowledge of, and desire to do, whatever is likely to be beneficial to mankind at large, in "bringing to light new truths, stimulating the progress of invention, discovery, and commercial enterprise, no less than educational reform."—T. R. J.

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[1] See Prof. Huxley's Memoir in the Popular Science Review, July, 1868, p. 237, and plates 27 and 28; also his Lecture, GEOL. MAG. Vol. V. p. 357.

II.—MEMOIRS OF THE GEOLOGICAL SURVEY OF IRELAND. EXPLANATION OF SHEET 105, ETC. DUBLIN, 1869.

THIS memoir, by Mr. G. H. Kinahan, on the geology of the district around Galway, possesses a melancholy interest in being, probably, the last of the published works of the Irish Survey, to which the late lamented Director affixed his signature. As will be seen by reference to the sheet (105), the entire district, with the exception of that portion occupied by surface deposits and the Carboniferous limestone, is composed of Igneous and Metamorphic rocks, and, therefore, possesses a special importance in a petrological and mineralogical point of view. The igneous rocks, described by the author, are coloured under three tints, respectively denoting, 1. Felstone, and porphyritic felstone; 2. Greenstone, or Diorite; 3. Granite, which last is divided into three subdivisions, viz.: Intrusive granite, foliated or stratified (?) granite, and porphyritic granite.

Commencing with the granite, a careful perusal of the Memoir, and an examination of the map itself, does not appear to warrant these subdivisions. In the first place, we can find no reason for considering the great mass of granite less intrusive than the small outlying bosses, which are expressly marked as intrusive, more especially since some parts of the great mass are also marked as intrusive, and no evidence is given which appears to justify the conclusion that this great continuous mass, and the other smaller masses, have more than one common origin; for this reason, therefore, notwithstanding Mr. Kinahan's somewhat elaborate attempt to infer such subdivisions, we are inclined to the opinion that the intrusive, foliated, and porphyritic granites form in depth but parts of one and the same mass. The statement (p. 7) that granite "becomes *Pegmatite* when Scapolite seems to replace part, or the whole of the felspar," will certainly not be accepted by Petrologists.

The remarks (p. 11) under the head of *Diabase* and *Diorite*, are so indefinite as to leave much doubt as to the real character of the rocks alluded to under these denominations. The observations made on the Gneiss of the district leaves an impression on the mind of the reader that the rocks, described under this name, are in reality only metamorphic schists further altered and rendered felspathic by the proximity of the great mass of granite, especially as they appear to be intercalated with nodular and calcareous schists, etc.

With reference to the conclusions (p. 15) arrived at, we must confess that we have found great difficulty in understanding the precise meaning of the author, especially with regard to his explanation of the ages of the various igneous rocks, since it is difficult to reconcile statements in the various paragraphs (p. 15) which nevertheless may be clearer in the mind of the writer. It is, however, suggested by Mr. Kinahan that the sedimentary rocks which are now metamorphose, previous to that action taking place, were the oldest in the district; that they were invaded by what are now the metamorphose hornblendic and felspathic intrusive rocks, and afterwards all were affected by the granite, which action ceased after the intrusive granite had been formed; and, at a still more recent period, the country was cut up by dykes of the more modern intrusive rocks (p. 15).

In perusing the remarks (pp. 16, 17) on "the supposed metamorphic eruptive rocks," and the mode of accounting for their modifications, we regard the evidence advanced in favour of his views as far from satisfactory; and somewhat tending to the doctrine of transmutation, too often so great a favourite with field geologists, especially when (p. 17) the disappearance, or alteration in appearance of the hornblendic rocks, by their "being incorporated in the granite" is spoken of, forgetting that there are serious objections, in a chemical point of view, to the acceptance of such a theory.

Mr. Kinahan, however, observes "that in the Porphyritic granite there are tracts in which hornblende, sphene, chlorite, and epidote, separately or combined, seem to become essentials of that rock; and is it not possible that such places point to localities in which hornblendic igneous rocks originally existed?"

Throughout the paper, many terms are made use of which are certainly objectionable as conveying somewhat indefinite meanings, such as tracts, courses, pipes, flying dykes, porphyries, etc., and in a petrological paper, we should expect the mineral species to be more exactly defined, and not for example to find a mineral described as "perhaps an earthy chlorite," whatever that may be.

The aqueous rocks and the relations between the form of the ground and its internal structure are subsequently noticed. The latter, an important and highly useful portion of all geological descriptions, we are glad to remark generally, if not always, finds a place in the 'Explanations' of the sheets of the Irish Survey.

The detailed descriptions as to the position and lie of the rocks, occupy the chief part of the Memoir, and evince a vast amount of labour on the part of the author, abounding as they do in carefully recorded facts, and many suggestive remarks well worthy the attention of the reader, both as to the mineralization and metamorphism the various rocks have undergone at different times, and as to the origin of the nodular and crumpled foliation in the metamorphic sedimentary rocks. The area described is divided into six districts, the first three are part of the country of the Carboniferous rocks, and the others of that in which granite and metamorphic rocks occur, followed by notices of the drift, alluvium, mines, minerals, etc. The author considers there are three well-marked classes of the drift, viz., *Boulder-clay drift*, *Boulder drift*, including rocky boulder drift and *Esker drift*, the first supposed to be of marine origin, the second of glacial, and the third or *Esker* to be the two former, well washed and sifted, perhaps by marine and tidal currents. Some notes on denudation, dressed rocks, striæ, etc., are given, accompanied by a table of supposed ice striæ, grouped according to the parts of the glacier or its branches to which they belonged.

Space will not allow of our entering more fully into the very extensive details of the descriptive geology of this Memoir, which nevertheless cannot fail to be of great service to those geologists whose travels may take them into this interesting district.

III.—JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND. 2nd Series. Vol. v. Part ii. 1869.

IN the Report of the Council of the Royal Agricultural Society, read at the General Meeting of the Society in May, 1869, it was pointed out that although their Journal contained valuable reports on the Agriculture of most of the English Counties, yet several years had elapsed since many of them were written, and that, in the present state of Agricultural practice and science, there was still much of interest to record in different localities. It was therefore advised to obtain more detailed information as to the management of particular districts, and to record anything peculiar in the system pursued upon special farms, to which gentlemen deputed by the Council have recently paid visits.

In the Journal now before us are seven Reports on Farms, prepared either by Mr. H. H. Dixon, or by Mr. H. M. Jenkins, F.G.S., the Society's Secretary, who visited the farms, accompanied in every case by a Member of the Council.

The reports are arranged geographically, as nearly as possible, commencing with a hill farm in the north, which is a gigantic sheep-walk, yielding only pasturage and mountain-hay, and coming gradually southwards through the Yorkshire Wolds, North Lincolnshire, Nottinghamshire, Norfolk, and Worcestershire, to a Wiltshire sheep-farm, which yields enough grass and green food to support a breeding ewe to the acre.

Various points of interest, and much useful practical information, are contained in these reports; the subjects treated of are—Geology and physical features, fences, drainage, ponds, grass-land, arable-land, manures, horses, cattle, sheep, pigs, labour, and farm buildings. As Mr. H. M. Jenkins has so lately been appointed to the post of Secretary to the Royal Agricultural Society, from the Assistant Secretaryship of the Geological Society, it is natural to find that from every farm which he visited we obtain an insight into its geological features, which adds a fresh interest to these reports for the farmer.

We will just briefly notice some of the geological features of the reports.

Taking them in order, we have—

1st. *A Hill and a Half-Hill Farm* (*Teviotdale*). By H. H. Dixon. —This report contains no geological references.

2nd. *Eastburn Farm, near Driffield, Yorkshire.* By H. M. Jenkins.—This farm, which contains about 1,300 acres, is situated on a spur of the Yorkshire Wolds.

Accompanying the report is a small map showing the surface-geology, after a survey by J. R. Mortimer, Esq. of Fimber; and also a brief description of the geology of the Wold range by the same gentleman, who is a well-known local geologist and antiquary.

Three kinds of subsoil are found to overlie the Chalk which forms the Wolds, two of which are represented on the Farm.

The *first* and most extensive is a small Chalk-rubble, with flints of various sizes derived from the Chalk beneath. It occurs on the northern and western escarpments of the Wolds, and on the southern and eastern slopes, where it attains a thickness varying from four to eight inches.

The *second* subsoil is a Drift-clay, sometimes containing, and at others replaced by, beds of a sandy nature. It covers the Chalk to a thickness of from 1 to 4 feet, and in places contains a great quantity of native angular flints stained with ferruginous matter. The soils on this deposit, which is mostly found on the hill-tops and the northern and western sides of the Wolds, are cold and 'unkind,' though deep. The deposit itself seems of a somewhat similar character to the "Clay-with-flints," which rests on the Chalk in some of the southern counties.

The *third* subsoil is a gravel, containing angular and subangular flints, with rounded fragments of granite, trap, quartz, sandstone, etc. It occurs on the bottoms of most of the Wold valleys, and in some places extends a little way up the sides of the hills.

Eastburn Farm contains, in addition to the last two of these subsoils, some "slightly raised banks of Chalk-gravel, between which are beds of peat, and occasionally clay," and also a loamy clay, which underlies these.

The gravelly land was very sterile, but a liberal supply of manures has rendered it tolerably productive.

3rd. *Aylesby, Riby, and Rothwell Farms, near Grimsby, Lincolnshire.* By H. M. Jenkins.—Boulder-clay, Silt-loam, Chalk-rubble, and Chalk are represented on these farms, which cover an area of 2,080 acres. These sub-soils all appear to have a loamy top-soil.

4th. *Nottinghamshire Farming.* By H. H. Dixon.—Two farms in South Nottinghamshire are here noticed by Mr. Dixon. Geological notes are also contributed by Mr. Jenkins.

5th. *The Lodge Farm, Castle Acre, Norfolk.* By H. M. Jenkins.—The geological features of the ground occupied by this farm are briefly pointed out; the deposits represented are the Brick-earth of the Nar, Boulder-clay, Drift-gravel, and Chalk. The Boulder-clay caps the Chalk-hills, the gravels occupy the valleys, but, as pointed out by Mr. Jenkins, they have nothing to do with the Nar or its valley; probably they are representatives of the "Middle Drift" of Mr. S. V. Wood, jun. The Brick-earth here lies in the river-flat; it is well known from the writings of Mr. C. B. Rose and the late Mr. Trimmer.

6th. *Pitchill Tilesford, and the Grove Farms, Worcestershire.* By H. M. Jenkins.—These farms are principally on Lias Clay, but there are traces of Rhætic, and Keuper beds, also Boulder-clay and sand.

7th. *Bulbridge and Ugford, near Salisbury.*—The area occupied by these farms is chiefly Chalk, which here gives a thin chalky soil, especially thin and chalky on the higher land.

The reports are illustrated by small maps, some on the scale of 1-inch to a mile, others on a scale of 2-inches to a mile. Most of them have been specially prepared by Mr. H. M. Jenkins.

A good geological map of England, showing the Drift deposits, would, doubtless, be of great service to Agriculturalists. Mr. Searles V. Wood, jun., has done much valuable work in paving the way by preparing and publishing Maps of the Eastern Counties (including Lincolnshire and part of Yorkshire), whereon the chief divisions of the Drifts are laid down. But these maps, although of the highest scientific interest, are on too small a scale to be of much practical service. His beautiful MS. Memoir and Maps of the Geology on sheets 1 and 2 of the Ordnance Survey, deposited in the Library of the Geological Society of London, are probably not so well known as they should be.

It is satisfactory to learn that the Geological Survey of England are preparing maps of the Drifts, where formerly they ignored these deposits. The want of these is evidently felt by Agriculturists, who will, doubtless, derive much benefit from this new feature in the Geological Survey Maps.

REPORTS AND PROCEEDINGS.

Geological Society of London.—November 10th, 1869. Prof. T. H. Huxley, LL.D., F.R.S., President, in the Chair. The following communications were read:—1. "Australian Mesozoic Geology and Palæontology." By Charles Moore, Esq., F.G.S. The author referred to the observations of Professor M'Coy and the Rev. W. B. Clarke, on the occurrence of fossils of Mesozoic age in Australia, and then proceeded to notice the species which he had obtained from that region. Fossils of Mesozoic type occur both in Western Australia and in Queensland; but the specimens have hitherto been found in apparently drifted blocks, and nothing is known of the bedded rocks from which they are derived. The author stated that the Australian Mesozoic fossils agree, not only in genera, but also in many cases in species, with British forms; and he gave a list of species from Western Australia, identical with British species, from the Middle and Upper Lias, the Inferior Oolite, and the Cornbrash. Of the fossils from Queensland, also, many are said to be identical with, very nearly allied to, British species; but the author regards the general type of the Queensland remains as indicating the Upper Oolite. A gigantic species of *Crioceras* is regarded by the author as possibly indicative of the occurrence of Neocomian deposits in Australia. The fossil evidence upon which Professor M'Coy inferred the occurrence of the Muschelkalk in Australia was said by the author to be nugatory, his supposed *Myophoria* proving to be a *Trigonia* nearly allied to *T. gibbosa* of the Portland Oolite, and his doubtful *Orthoceras* a small *Serpula*. The author had found no indications of the existence of Triassic or Liassic deposits in Queensland.

The blocks from Western Australia, referred by the author to the Middle Lias, contain *Myacites liassianus* (Quenst.), and are quite as highly ferruginous as the English Marlstone. The species identified by the author with British Oolitic species would indicate a range from the Inferior Oolite to the Cornbrash. The author suggests that the species may have had a longer range in time in Australia than in England, or that the subordinate divisions of the Oolite were not clearly marked in the Australian Mesozoic deposits. He is inclined to refer the fossils to the period of the Inferior Oolite.

The author inferred, from the occurrence of these Mesozoic fossils in drifted blocks at the two extremities of Australia, separated by 38° of longitude, that an enormous denudation of rocks of the Secondary series has taken place over a considerable part of Australia.

Descriptions of a great number of new species were appended to the paper.

2. "On a Plant and Insect-bed on the Rocky River, New South Wales." By Charles Moore, Esq., F.G.S.

The organic remains noticed by the author were found by him in a small block of chocolate-coloured, micaceous, laminated marl, obtained from a bed about ten feet thick, at a depth of 100–110 feet, in the auriferous drifts of Sydney flats, on the banks of the Rocky River. The author found the leaves of two forms of Dicotyledonous plants, fragments of a flat narrow leaf, which he refers to the Coniferæ, a seed-vessel, and the impressions of several seeds. The insect-remains consist principally of the elytra of Beetles, among which Buprestidæ appear to predominate. The vegetable-remains seem to indicate that the deposit is of Tertiary age.

Discussion.—Professor T. Rupert Jones mentioned the discovery of a large *Crioceras* in the Jurassic beds near Port Elizabeth.

Mr. W. Boyd Dawkins suggested that we had hardly a right to apply the European standard in judging fossils from all parts of the world, and doubted whether, if these fossils were examined from the purely Australian point of view, the same age would be assigned to them.

Mr. Seeley agreed with Mr. Dawkins, and argued, from the existence of natural groups in different areas of the globe, that the same must have been the case in former ages.

Mr. R. Tate remarked that if Mr. Moore had compared the Jurassic fauna with those of India, Africa, and Chili, he would have found the same mixture of forms belonging apparently to different horizons. He considered that the Australian fossils probably represented our Middle Oolite. He did not quite agree with the author as to some of the specific determinations.

Dr. Duncan remarked that the same combination of forms separated in Europe was found among the Tertiary fossils of Australia. He thought that further facts were necessary before forming a decided opinion as to the succession of the beds in that continent.

The President remarked that when we talked of identity of fauna in Australia and this country, improbable as it might appear, we must remember that at the present time identical species and, to a great extent, a similar fauna, were to be found in our seas more than 180° apart.

Mr. Moore, in reply, argued that it was the safest plan to follow the well-established standard of Europe even in remote parts of the world. He was inclined to refer the bulk of the specimens rather to the Lower than to the Middle Oolite, but otherwise he agreed in the main with Mr. Tate.

3. "On *Hypsilophodon*, a new Genus of *Dinosauria*." By Professor Huxley, F.R.S., President.

The author described the characters presented by the skull of a small Dinosaurian reptile obtained by the Rev. W. Fox from a Wealden bed at Cowleaze Chine, in the Isle of Wight. One of the most striking peculiarities of this skull was presented by the præmaxillary bone, which seems to have been produced downwards and forwards into a short edentulous beak-like process, the outer surface of which is rugose and pitted. The author remarked upon the known form of the symphysial portion of the lower jaw in the Dinosauria, and indicated that its peculiar emargination was probably destined to receive this beak-like process of the præmaxillaries, which may have been covered either by fleshy lips or by a horny beak. The dentigerous portion of the præmaxilla bears five small conical teeth. The alveolar margin of the maxilla bears ten teeth, which are imbedded by single fangs, and apparently lodged in distinct alveoli. The summit of the crown, when unworn, is sharp and presents no trace of the serrations characteristic of *Iguanodon*; but it is sinuated by the terminations of the strong ridges of enamel which traverse the outer surface of the crown. The teeth thus present some resemblance to those of *Iguanodon*; but the author regarded the two forms as perfectly distinct, and named the species under consideration *Hypsilophodon Foxii*. Of the lower jaw the right ramus is present; but its distal extremity is broken off, and its teeth are concealed. On the outer surface of the lower jaw the centrum of a vertebra is preserved.

The author then referred to a fossil skeleton in the British Museum, which has been regarded as that of a young *Iguanodon*; it is from the same bed as the skull previously described. The author remarked that, in form and proportions, the vertebræ were quite different from those of *Iguanodon*, and apparently identical with those of his new genus, as shown by the centrum preserved with the skull: the animal had at least four well-developed toes; and other peculiarities were indicated, which seem to prove that it was quite distinct from *Iguanodon*. This skeleton the author identified with his *Hypsilophodon Foxii*, and described its characters in detail, dwelling especially upon the peculiarities of the pelvic bones, which are singularly avian in their structure.

4. "Further Evidence of the Affinity between the Dinosaurian Reptiles and Birds." By Professor Huxley, F.R.S., President.

In this paper the author reviewed the e
himself and others (especially Professor H
the ornithic affinities presented by the Di
length the recently ascertained facts which
some of the most important of which are
described by him in the preceding paper
Hypsilophodon Foxii. He summed up his paper
different elements of the pelvic arch and h
reptiles the Dinosauria and Birds, and main
of the pelvic bones (especially the form and a
and pubis), the relation between the distal e
astragalus (which is perfectly ornithic), and
of the tibia and the direction of its twist,
important evidence of the affinities betw
Birds.

Discussion.—Sir Roderick Murchison, who had t
the habits of the *Hypsilophodon*.

Mr. Hulke mentioned that Mr. Fox had two blocks
portions of the *Hypsilophodon*, all procured from a
Cowleaze Chine. On one the pelvis is almost entire,
the tibia, which is longer than the femur, four lo
astragalus. All the long bones are hollow. Portions
have been found in the same bed.

Mr. Seeley doubted whether these animals should be
seemed to him to form a group distinct alike from rept
occupying an intermediate position. In the hinder
analogies were closer with mammals than with birds.
the peculiar structure of the hinder limbs of the Dinos
they performed rather than to any actual affinity with b

The President, in reply, stated that *Hypsilophodon*, f
probably subsisted on hard vegetable food. He express
allow a closer examination of his specimens to be mad
with Mr. Seeley's views. He was inclined to think tha
tended rather to break down the lines of demarcation b
distinct than to authorize the creation of fresh divisions

CORRESPONDE

THE CHESIL BANK.

Sir.—The letter of Colonel Greenwood
the Chesil Bank," in the last number of the
is so discursive, and takes up so many
treated of in *our* [1] paper on the subject, that
to answer briefly.

As far as we can gather, the two chief obj
in view are:—1stly, to complain that we
term "natural groin" used by him in refere
which he reserves the exclusive right; an
less is known on the subjects on which he h
willing to allow.

Not taking into account collateral issues and confining ourselves as closely as possible to the main subject, we may state that, if we had thought that the raised beach at Portland Bill had been in any way connected with the Chesil Bank, we should have said so in our paper; but we have no doubt but that the former is far older (a part, indeed, of that so often found at the same height, as near Torquay); and we see no reason to *imagine* either sinking or rising of the land to explain the formation of the latter.

---

[1] I feel bound to notice the strange way in which
used my name alone in his letter, without any reason, a
joint work of Mr. Bristow and myself.—W. Whitaker

As to the "adoption" of the term "natural groin"—if one is bound to put in inverted commas any two words that have been printed together before, the articles in the GEOLOGICAL MAGAZINE will be little else than a mass of quotation. Such a term is so simple that it might at once occur to any one, as well as to the author of "Rain and Rivers," and might be used without any thought of appropriation.

We have distinctly stated in our paper that with the question of the heaping up of the beach we had nothing to do, and that it has been fully gone into by others; therefore it is absurd to tax us with avoiding that question.

The "*assumed* current" that Col. Greenwood speaks of is also well known, of course going along with "the prevalence of south-west winds."

We do not consider "the shingle of the Chesil beach to be in an *anomalous* position" simply because "it is longer than other beaches," etc., as a careful reader of our paper would see at once, but because it is differently placed to any other mass of shingle in the kingdom, having the sea on both sides and joining what would else be an island to the mainland.

We must emphatically dissent from the statement that the travelling of sea-beach is "a subject on which profound ignorance prevails:" were Col. Greenwood as ready to refer to other authorities as he is to find fault with writers who do not refer to him he would hardly have made such a statement. We may particularly draw attention to the papers by Mr. Redmann (on the south-eastern coast)[1] and to the older essay by Colonel Reid,[2]—to Mr. Coode's paper we have already referred.

Col. Greenwood seems to have lost sight of the chief aim of our paper, which is to show that the Chesil beach may have been formed where it now stands, but against the land, which being then worn away by the small streams, etc., the beach became isolated,—a theory which we venture to say has not been broached in any work, not even in "Rain and Rivers;" and we may as well state that this idea occurred to one of us whilst mapping the Dorset country more than twenty years ago, long before Col. Greenwood's work was published; although not then having the clue to the phenomena of subäerial denudation,[3] it went no farther than conversation.

H. W. BRISTOW. W. WHITAKER.

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[1] Published in the Proc. Inst. Civ. Eng.

[2] Published in the Papers of the Royal Engineers. We are away from books, and so cannot give references exactly; indeed, we have not even a copy of our own paper with us, nor of "Rain and Rivers."

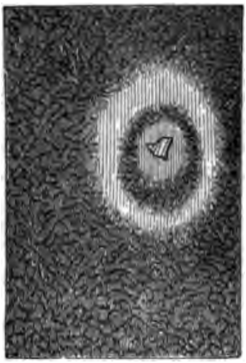
[3] We readily acknowledge the good work done by Col. Greenwood in illustration of this subject.

ON A PECULIAR FORM OF VARIEGATION IN CAMBRIAN SLATE.

SIR,—I send herewith a sketch of a rather unusual form of variegation occurring in a slab of Cambrian Slate. I observed it a short time back at Reading, but am not aware of the exact locality from whence the slate was obtained—probably, however, from the Penrhyn or Llanberis quarries. As it bears on the question of the causes that have induced the parti-colored banding of variegated rocks, you may perhaps give it a place in the MAGAZINE.

The ordinary form of variegation of Cambrian Slates consists of mechanical nuclei and layers of interbedded matter concentrically environed by pale green slate, the bleaching of which has been due to the abstraction of the greater part of the colouring oxides of iron.

In a paper contributed to the Geological Society (Quart. Journal of Geological Society, Nov. 1868), and a communication which appeared in the GEOLOGICAL MAGAZINE for March, 1868, I endeavoured to shew that this abstraction was independent of the mere mechanical washing-out in a soluble condition of the colouring oxides. The example represented in the accompanying engraving seems to support this view. Here we have not only a bleached zone immediately adjacent to the central nucleus, but a second concentric zone separated therefrom by an intervening band of unaltered slate. It is obvious that the positions of both the inner and outer pale zones have been determined in some way by the little mechanical nucleus, and if the discolorations were due to the mere solvent action of matter emanating from it, it seems impossible to account for the intervention of the unaltered zone entirely isolating the outer pale band from the inner zone and the central fragment of foreign matter. GEO. MAW.


Quarter Actual Size.

BENTHALL HALL, BROSELEY,
November, 1869.

SUCCESSOR TO THE LATE MR. JUKES.—Mr. Edward Hull, M.A., F.R.S., F.G.S., has been appointed Director of the Geological Survey of Ireland, and Professor of Geology in the Royal College of Science, Dublin, in the room of the late Mr. Jukes. Mr. Hull had not long before been chosen a District-Surveyor on the Geological Survey of Scotland.

ERRATUM.—A serious erratum occurred in our November Number (after it had been sent to press). In shifting the form, *a line of type* —belonging to the Obituary Notice of Dr. Rubidge—was removed by the printer from the foot of p. 527, and inserted at the foot of p. 525, entirely destroying the sense of both the Obituary Notice and of Mr. R. Craig's Letter.—EDIT.

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